How To Keep Your Tent Toasty

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ABSTRACT

Thermal comfort is an important issue when dealing with backcountry activities. An outdoor enthusiast must always be concerned with maintaining a comfortable temperature that allows them to be functional at an optimal level. Numerous methods have been developed for backcountry users to achieve and maintain a desired temperature, most of which involve the transportation of additional insulative materials. We wanted to explore alternative methods of thermal maintenance in the backcountry that could be applied to situations where the user is ill prepared for unanticipated weather conditions. It is common for backcountry users to be caught off guard in rapid weather changes. The methods we wanted to investigate involve using surrounding natural elements to insulate in the absence of proper insulation. This would give users a tool to protect themselves against the harsh realities of the wilderness.

1. INTRODUCTION

This study is a term project assigned for Environmental Control Systems 1 (ECS 1), a class offered at the University of Oregon as part of the Architecture Program. An interest in wilderness survival was the initial inspiration for our study. In recent years there has been a popular interest in survival skills for extreme situations. Television shows such as the *Survivor Man* and *Man vs. Wild* are examples of how the idea of surviving in the wilderness has caught the interest of millions of viewers around the world.
We chose to conduct this experiment in order to further investigate the concepts of thermal insulation and heat loss within a living environment. The purpose of this study is to investigate the living situation of a traveling backpacker lost in the wilderness or caught in a situation that called for additional insulation strategies. Proper thermal insulation is most crucial during the night when temperatures drop and heat loss may occur through radiation and convection within a tent. The group will be exploring the thermal properties of natural materials readily available in the Oregon wilderness. Using these materials, we will develop strategies for insulating a typical two-man tent overnight with one body sleeping.

Our study of different methods of insulating a tent could be applied to real life situations where a lack of thermal insulation may be a concern. The study will take place on the lawn of our back yard in Eugene, Oregon, a fairly wet climate of the Northwest. Here we will be able to test various methods of insulating a tent overnight in a cool region. Data collection will take place over the course of a week.

2. THE PROBLEM & HYPOTHESIS

People often experience thermal discomfort in their tents while camping. We intend to investigate this problem by looking into alternative strategies for increasing the insulation quality of a typical two-man tent with one person sleeping overnight. We predict that we can increase the interior temperature of a two-man tent by 10 % by applying different naturally occurring materials to the exterior of the tent.

3. METHODOLOGY & EQUIPMENT

To conduct this experiment we will have a group member (Jim) sleep in a tent over night, for 3 nights. We will log temperature and humidity measurements using HOBO data

loggers on the interior and exterior of the tent (Figure 1.1). The exterior HOBO will be placed near the tent in a dry area to avoid damage to the equipment. The interior HOBO will be hung in the middle of the tent to ensure accurate measurements for the tent environment. Data will be recorded at half-hour intervals for 10 hours, from 11:30PM to 9:30AM, on the selected nights.

Fig. 1.1 - HOBO data logger

The first night we will take readings from the Hobo with one member sleeping in the tent alone with no additional insulation. This will allow us to compare our data to a control. The second night we will cover the exterior of the tent in pine tree bows until the tent is no longer visible. We will then measure the additional insulation values this would add. This step will be repeated the third night with straw that we apply to the tent using a web of string to support the small pieces. We will analyze the data that is recorded from the HOBOS over the three nights and calculate which natural element would provide the greatest insulation.

4. RESULTS

5.1 Insulation Properties of Natural Materials: Night 1 (No Additional Insulation)

The temperature and relative humidity (RH) of the inside of the tent and its exterior environment was recorded every 30 minutes beginning at 11:30PM on March 8th 2010, and ending at 9:30AM March 9th 2010. The tent was erected under an overhead shelter but no additional insulation was used (Figure 1.2). The average temperature of the interior of the tent was about 6.5°F higher than the exterior temperature (Figure 1.3). On average the tent's RH level was about 13.3% higher than the exterior RH (Figure 1.4). Since there was little difference between our interior and exterior measurements, we surmised that the tent provided virtually no insulation. We suspect that the only reason for the difference in RH value and temperature is simply because there was a barrier (tent wall) retaining some of the radiant heat given off by Jim.

Fig. 1.2 – Image of Two-Person tent used in the study.

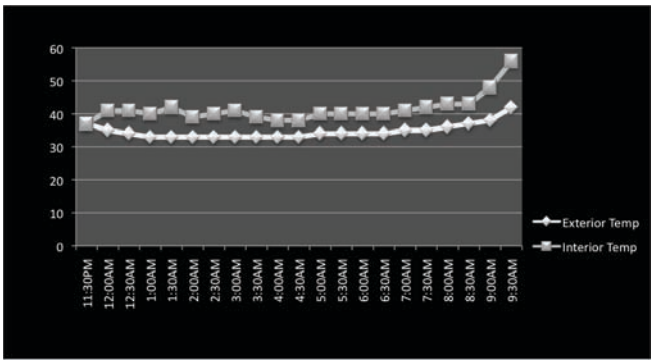

Fig. 1.3 – Graph of temperature recordings for Night 1 (No Additional Insulation).

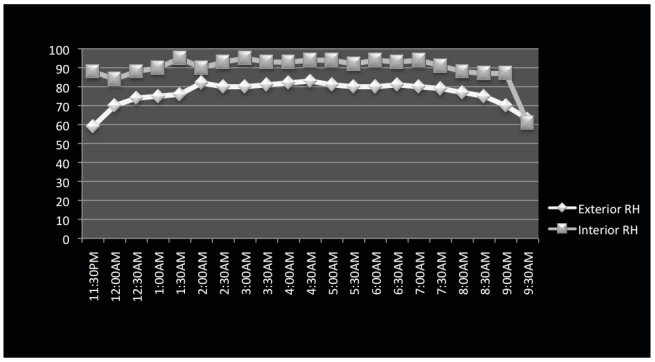

Fig. 1.4 – Graph of Relative Humidity recorded by data loggers for Night 1 (No Additional Insulation).

5.2 Insulation Properties of Natural Materials: Night 2: (Pine Boughs as Insulation)

Measurements were logged at the same intervals as in night 1, beginning and ending at the same times: 11:20PM on March 9th 2010, to 9:30AM on March 10th 2010. This time Douglas-fir boughs were stacked on and around the tent until the tent was no longer visible (Figure 1.5). The average temperature of the interior of the tent was approximately 12°F higher than the outside temperature (Figure 1.6). The RH level of the tent gradually increased at a very slow rate, whereas the exterior RH level decreased exponentially. This could be subject to the fact that there

was precipitation early in the night that eventually soaked through the materials and reached the interior of the tent. The average RH level in the tent space was about 10.5% higher than that of the exterior (Figure 1.7). We knew that the tent would retain more heat and humidity simply because there was another layer inhibiting the transfer of heat and humidity between the two environments.

Fig. 1.5 – Image of Douglas Fir Boughs applied to tent.

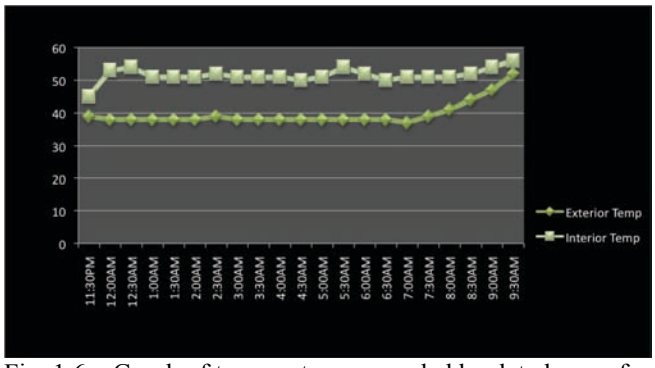

Fig. 1.6 – Graph of temperatures recorded by data logger for Night 2 (Pine Bough Insulation).

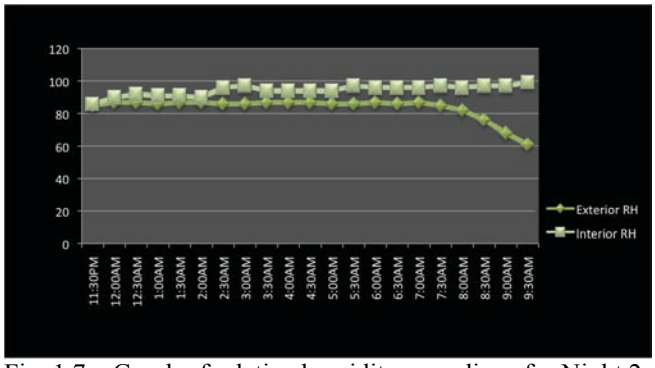

Fig. 1.7 – Graph of relative humidity recordings for Night 2 (Pine Bough Insulation).

5.3 Insulation Properties of Natural Materials: Night 3: (Straw as Insulation)

Measurements for the third night were recorded at the same intervals: from 11:20PM on March 10th 2010, ending at 9:30AM on March 11th 2010. This night the tent was covered with straw using a web of string until it was no longer visible (Figure 1.8). The average temperature of the interior of the tent was 27°F higher than the exterior temperature over the duration of the night (Figure 1.9). Using straw as insulation provided the highest interior and exterior temperature difference seen thus far in the experiment. This was also the first time where the RH level was lower inside of the tent than on the outside. The average difference was 15.57% lower (Figure 2.1). The average temperature recordings were at their highest when compared to the temperatures ascertained from the previous nights' experiments.

Fig. 1.8 – Image of Straw applied to tent.

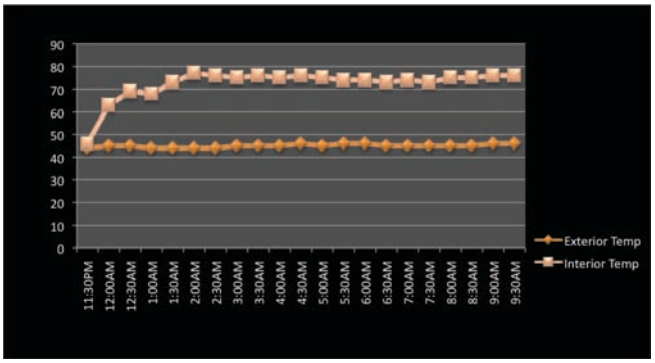

Fig. 1.9 – Graph of temperatures recorded for Night 3 (Straw as Insulation).

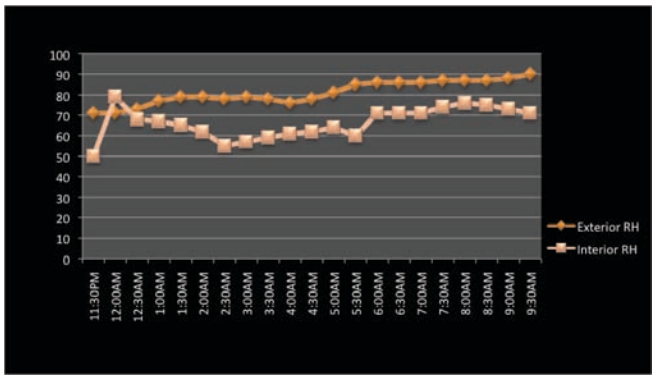

Fig. 2.1 – Graph of Relative Humidity recorded by data loggers for Night 3 (Straw as Insulation).

5. DISCUSSION

Sleeping outdoors in a tent is often associated with thermal discomfort. The average nylon tent lacks adequate insulation properties inspiring the need for additional layers of material to be added. Applying additional layers of material to the exterior of the tent provides a thicker envelope reducing the transfer of heat between the interior and exterior environments. Heat produced by the body may be contained and more successfully recycled within the interior when there is more material between the two environments. In the study we found that the simple addition of natural materials can create a more comfortable thermal atmosphere within the tent space. The most successful applications seem to be ones that create a layer of material and air space within the tents envelope. Straw was a very successful insulator because it is made up of hundreds of straw stalks, each containing and trapping air. Air can be a great form of insulation if you can keep it still and dense, which straw achieves.

6. CONCLUSIONS

The tests we performed and the data we gathered shows that it is possible to increase the interior temperature of a one-man tent by 10% by using natural insulating elements. As a result, our hypothesis was proved to be plausible. The practicality of applying these strategies in the field may vary depending on the available resources, but the concept of applying additional insulation to the exterior of a tent can be an effective solution to maintaining a comfortable temperature in the backcountry.

It is difficult to engineer a tent that is successful at creating a comfortable atmosphere when considering both temperature and RH values. The thin, permeable walls of the tent allow for the release of built-up humidity, but also allow for the release of warm air. Creating a non-bulky, lightweight tent that produces thermal and RH comfort often requires a trade-off that doesn't satisfy all of the requirements. The permeable material that most tents are manufactured with is usually more successful at maintaining a comfortable RH value than a comfortable temperature. It's unrealistic to expect a cloth wall that is less than 1/32" to be a good temperature barrier. There is not much more that the tent itself could do without taking more away from thermal or RH quality. Better ventilation could be created if more screen was used at the top of the tent, than solid cloth, but this would also let heat out. The walls could have been thicker, but they would consequently result in a heavier, bulkier tent. The use of individual equipment like space heaters, dehumidifiers would absolutely assist in making the tent more comfortable. However these solutions are not practical in a campsite setting.

Our solution entails using organic materials that occur naturally in most campsite settings, which alleviates the "non-bulky and lightweight" requirement since the materials do not need to be carried around with the user. Adding insulation under the floor of the tent would also undoubtedly assist with thermal comfort, though this was not done in our experiments. We concluded that straw proved to be the best insulator not only because it dramatically helped boost the interior temperature, but because it kept the RH level down. The prowess straw demonstrated maintaining a comfortable temperature was not surprising since properly constructed straw-bale houses have been commended for performing above-and-beyond in this area.

7. ACKNOWLEDGMENTS

We would like to extend an appreciation to: Diess Feed and Seed for providing the straw that was used in the study; to Max, the owner of the tent that was used to conduct the experiment; to Jim, who was willing to sacrifice his time and comfort to sleep in the tent for three nights.

8. REFERENCES

No references were used in this study.