RIT MSD I - P17701: Goodwill/ABVI Cotton Upcycling

Fall Semester, 2016

Team Members: Lucas Jackling, Mitch Goepel, Denning Crenshaw, Josh Kon

Performance of Thermal Insulation

Preliminary Test Plan - Revision 1

11/2/2016

RIT MSD I - P17701: Goodwill/ABVI Cotton Upcycling

Fall Semester, 2016

Team Members: Lucas Jackling, Mitch Goepel, Denning Crenshaw, Josh Kon

Purpose:

The purpose of this test plan is to establish a means for testing and evaluating the thermal insulation performance of cotton insulation prototypes as constructed by RIT MSD team P17701. In industry, the insulating power/performance of a thermal insulation product is characterized by its "R-Value", with thicker insulations generally having a higher R-Value. The industry standard test used to determine an insulation's R-Value is *ASTM C-518.*

Scope:

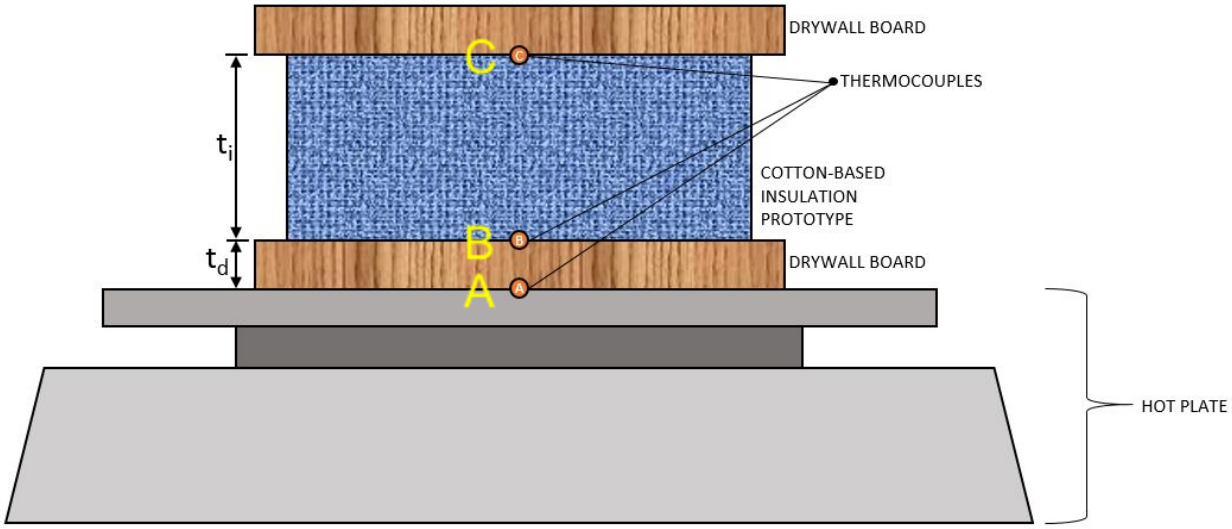
The following testing procedure does not and will not establish an R-Value for an insulation prototype which is a certified or backed by any standards agency. The test method described below simply serves to provide an estimate of the prototype's R-Value as well as the thermal conductivity of the prototype material, and will primarily be used as a *comparative test.* The results of this test will indicate to the team which prototypes perform better as thermal insulators and provide a means for decision making.

RIT MSD I - P17701: Goodwill/ABVI Cotton Upcycling

Fall Semester, 2016

Team Members: Lucas Jackling, Mitch Goepel, Denning Crenshaw, Josh Kon

Experimental Setup:



Test Parameters:

$$"A" = Hot\ Plate\ Surface$$
$$"B" = Insulation\ Warm\ Side$$
$$"C" = Insulation\ Cool\ Side$$
$$T_A, T_B, T_C = Thermocouple\ temperature\ at\ respective\ locations$$
$$t_d = Drywall\ Thickness$$
$$t_i = Insulation\ Thickness$$
$$k_d = Thermal\ Conductivity\ of\ Drywall\ Material$$
$$q = 1D\ Heat\ flux\ through\ "wall"$$
$$** k_i = Thermal\ conductivity\ of\ Insulation$$
$$** R_i = Tested\ R-Value\ of\ Insulation$$

** These numbers are the desired output of the analysis

RIT MSD I - P17701: Goodwill/ABVI Cotton Upcycling

Fall Semester, 2016

Team Members: Lucas Jackling, Mitch Goepel, Denning Crenshaw, Josh Kon

Procedures and Theory:

1.) An insulation prototype is set up on a hot plate which serves as an isothermal surface, then instrumented with thermocouples at the locations shown
2.) The hot plate is energized until thermocouple "A" reads a constant temperature
3.) Once all thermocouples temperature readings become constant with time, a steady-state condition has been reached, and the temperatures at A, B, and C are recorded

According to the theory of steady-state, one dimensional heat conduction, the heat flux through the wall can be found with temperatures A and B along with the thermal conductivity of the drywall material.

$$q = k_d \frac{T_A - T_B}{t_d} \tag{1}$$

Since this is the same heat flux which is traveling through the insulation prototype (assuming the sides are well-insulated so that side heat losses are prevented), the thermal conductivity of the insulation material can be calculated as follows:

$$k_i = \frac{q t_i}{T_B - T_C} \tag{2}$$

The overall formula for calculating the thermal conductivity of the insulation material given the test data and handbook information is as follows:

$$k_i = \frac{(k_d \frac{T_A - T_B}{t_d}) t_i}{T_B - T_C} \tag{3}$$

A comparative R-Value may be found once the insulation thermal conductivity, k_i, has been calculated, and given the thickness of the prototype:

$$R_i = \frac{k_i}{t_i} * 5.678 \tag{4}$$

RIT MSD I - P17701: Goodwill/ABVI Cotton Upcycling

Fall Semester, 2016

Team Members: Lucas Jackling, Mitch Goepel, Denning Crenshaw, Josh Kon

Results:

Test Data	Value	Units
T_A		
T_B		
T_C		
t_d		
t_i		
Calculated Quantity	**Value**	**Units**
q		
$\mathbf{k_i}$		
$\mathbf{R_i}$		

Discussion: