Boeing Design of Experiment (DoE) on Radiant Heat Test

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Design of Experiment (DoE)

- Design of Experiment (DoE) provides a systematic, disciplined approach to determine which potential factors cause variance in a process.
- 1st screening experiment to reduce the variables to those that impact the test
- 2nd high resolution experiment to investigate relationships of remaining variables
- This screening DoE used is a fractional factorial with Resolution=3
- Boeing DoE on Radiant Heat Test examined 18 variables, made 256 burns, lasted 2 days

Test Variables

- Equipment
- Process
- Sample

Test Variables

Equipment

Variable	Level 1	Level 2	Requirement
Equipment Start Up	Open Drawer	Closed Drawer	-
Heat Flux	2.1 W/cm^2	1.3 W/cm^2	1.7 W/cm^2
Flame Length	7/8”	1/2"	3/4"
Flame Angle	30^o	20^o	27^o
Flame distance from end	2 7/8”	1 3/8”	1 7/8”
Flame Time	20 sec.	10 sec.	15 sec.

Test Variables

Process

Variable	Level 1	Level 2	Requirement
Chimney	Closed	Open	-
Specimen Preheat	3 sec.	0	-
Drawer Open Time	60 sec.	30 sec.	-
Test board length	42” (full length)	24” (sample length)	-
Test board temperature	160^{o} F	70^{o} F	-
Sample holder	Large flat holder	Small angle holder	Small angle holder

Test Variables

Sample

Variable	Level 1	Level 2	Requirement
Construction	Stitched	Taped	-
Covering Material	HFR Mylar	Polymer Coated Fabric	-
Fiberglass Density	1.5 pcf	0.34 pcf	-
Fiberglass Thickness	2”	1”	-
Humidity Conditioning (24 hrs)	80% @ 70F	30% @ 70F	-
Fiberglass – usage	New	Pre-burned	-

DoE on Radiant Heat Test

Jobs

- Loader
  1. Open Drawer
  2. Load boards
  3. Load sample
  4. Load sample holder
  5. Close Drawer
- Board Provider
  1. Long or short
  2. Preheated or room temp.
  3. 1 or 2 boards
- Board Runner
  1. Take hot boards from oven, give to Board Provider
  2. Replace Hot Boards in over
  3. Put Burned specimens in garbage
- Timer
  1. Drawer open time
  2. Sample preheat time
- Chimney closer
  1. Open, close chimney
  2. Provide sample holder to Drawer Opener
- Igniter
  1. Flame Angle
  2. Flame distance
  3. Measure flame propagation
- Test timer
  1. Measure flame time
  2. Measure after burn time
  3. Provide sample to loader
- Recorder
  1. Record after burn time
  2. Record flame propagation length

Test Results

- Minor or No Affect
- After burn
- Burn length

Test Results

Minor or No Affect

Equipment

- Equipment Start UP
- Flame Length
- Flame Distance from end

Process

- Test Board Temperature
- Specimen Preheat
- Sample holder
- Drawer Open Time

Sample

- Construction
- Humidity
- Fiberglass usage

Test Results

After Burn

	Worst Condition
• Flame time	10 seconds
• Chimney	Closed
• Heat Flux	2.1
• Test Board Length	24”
• Flame Angle	20^{o}
• Sample Thickness	2”
• Fiberglass Density	0.34 pcf

DoE on Radiant Heat Test

Test Results

Burn Length

	Worst Condition
• Fiber Density	0.34 pcf
• Chimney Closed	Closed
• Board Length	Long
• Heat Flux	2.1