Effects of New Jet Fuel Exposure on Aerospace Composites

Federal Aviation Administration

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MISSISSIPPI STATE

Joint Centers of Excellence for Advanced Materials

JAMS Technical Review

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Introduction

Project Title: Effects of New Jet Fuel Exposure on Aerospace Composites

Project Participants

- **Principal Investigators:** Santanu Kundu, Matthew W. Priddy, Thomas E. Lacy Jr., Charles U. Pittman Jr.
- **Graduate Students:** Naoufal Harich

FAA Technical Monitor

- Dave Stanley

Industry Partnerships/Other Collaborations: Aurora Flight Sciences, Advanced Composite Institute (MSU)

Source of matching contribution for the current award: Aurora Flight Sciences, MSU, and TAMU

Literature Study: Effects of JP4 Fuel Uptake on Composites

[illegible]

Material Systems: Fuels

ATJ/SPK: Alcohol-to-Jet to Synthetic Paraffinic Kerosene

HEFA/SPK: Hydroprocessing Esters and Fatty Acids to Synthetic Paraffinic Kerosene

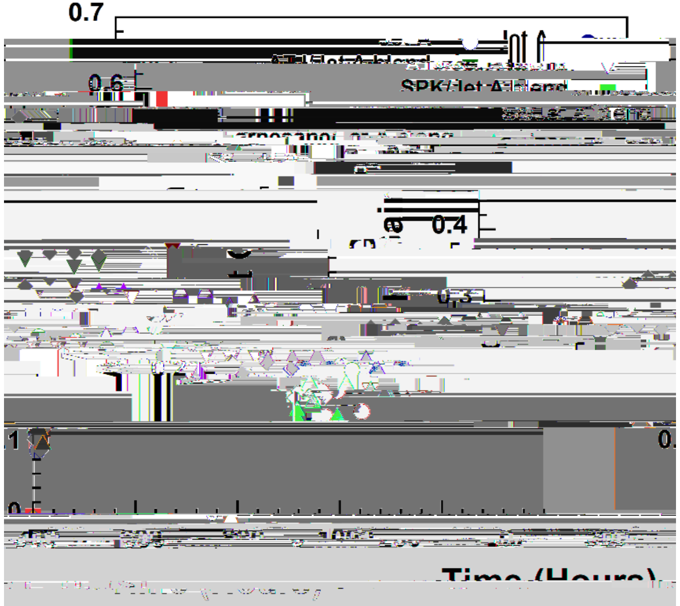
Weight Gain with Time for Autoclave Quasi-Isotropic Hexcel SGP370-8H/8552 Carbon/Epoxy immersed in Jet A fuel

The ***average fuel uptake*** and a Bezier trendline. Error bars represent the standard deviation.

Faster **absorption** in the **early stages** of the fuel immersion

The equilibrium weight gain was of 0.27% and the range [L-H] of [0.18 - 0.35] %

Average Weight Gain with Time for Autoclave *Cross-Ply Hexcel SGP370-8H/8552* Carbon/Epoxy



Jet A fuel
50/50 ATJ/Jet A blend
50/50 SPK/Jet A blend
50/50 S8/Jet A blend
20/80 Farnesane/Jet A blend

Faster

Experimental Details: DMA

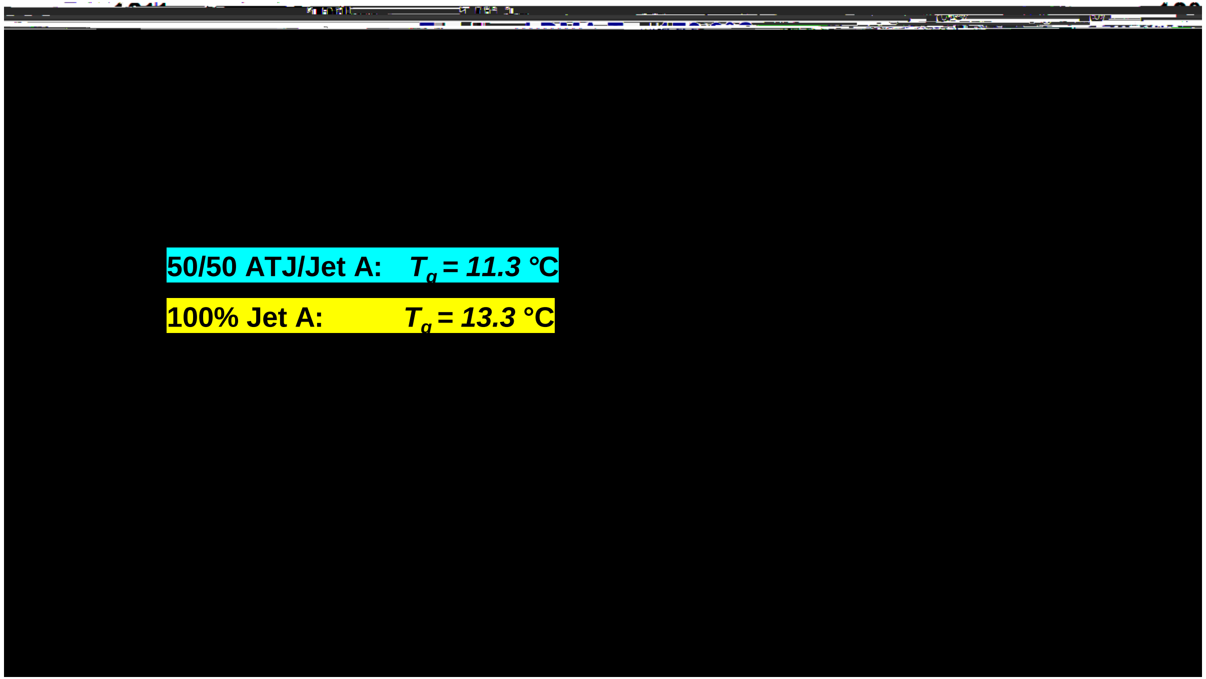
The effects of fuel absorption on the **thermomechanical properties** of composites are studied using **Dynamic Mechanical Analysis (DMA)**.

DMA was **performed** on **neat and fuel-immersed** specimens using an **RSA-G2 Solids Analyzer** with the **three-point bending** mode.

The analysis was performed following the

Experimental details: DMA (cont.)

DMA Results for Autoclaved Cross-ply Hexcel SGP370-8H/8552 Carbon/Epoxy Specimens: Neat and Immersed in ATJ/Jet A Blend



Absorption of Model Fluids

MSU has limited access to alternative fluids, particularly unblended ones.

Model fluids with **similar chemical structure** as the **pure alternative fuels** will be used.

Use **100% (neat) alternative fuels** and investigate their **effects on carbon/epoxy specimens**.

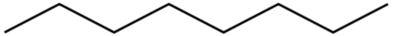
These **pure alternative fuels** are comprised **mostly of paraffins and olefins** and have almost **no aromatics.**

Sample thickness will be **varied-** higher thickness leads to **slower diffusion.**

Accelerated absorption using **different temperatures** will be performed on the **thicker specimens.**

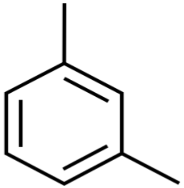
Material System: Model Fluids

Model fluids to be used:



Octane

Nonane



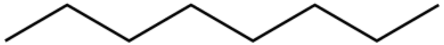
Xylene

Jet Fuel Composition [4]

[4] Sustainable bio-derived synthetic paraffinic kerosene (Bio-SPK) jet fuel flights and engine tests program results. *9th AIAA aviation technology, integration, and operations conference (ATIO) and aircraft noise and emissions reduction symposium (ANERS)*, (p. 7002).

Preliminary Results: Absorption

<u>Autoclave cured Hexcel SGP 370-8H/8552 quasi-isotropic</u> specimens after **3500h**

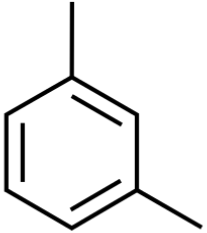


Octane

Average equilibrium weight gain: 0.21%

Nonane

Average equilibrium weight gain: 0.21%



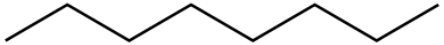
Xylene

Average equilibrium weight gain: 0.22%

Low model fluids absorption**, similar to the** alternative fuels
Aromatic and **aliphatic** model fluids display **similar** uptake v

Preliminary Results: Weight Tracking

<u>Autoclave cured Hexcel SGP 370-8H/8552 cross-ply</u> specimens at **3500h**

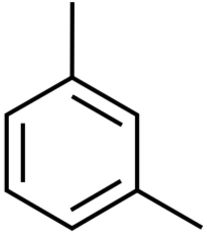


Octane

Average equilibrium weight gain: 0.09%

Nonane

Average equilibrium weight gain: 0.18%



Xylene

Average equilibrium weight gain: 0.16%

Low model fluids absorption**, similar to the** alternative fuels

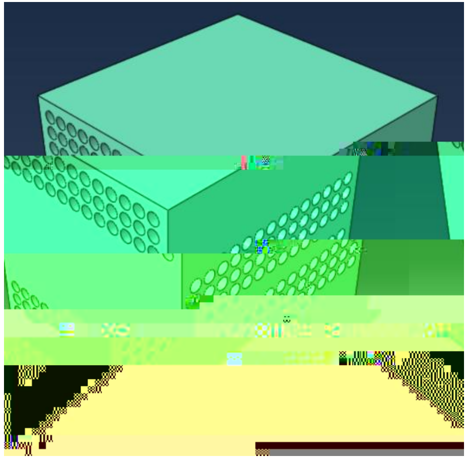
Aromatic and **aliphatic** model fluids display

Diffusion Modelling

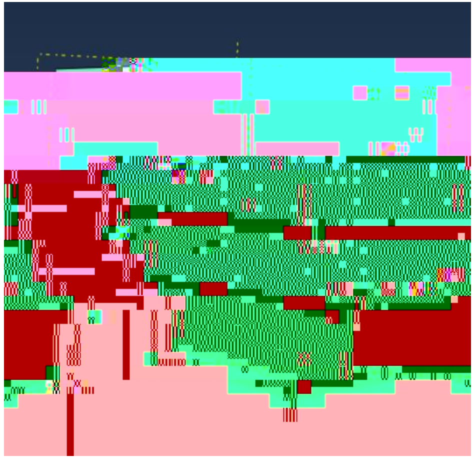
Diffusion Modelling

Initial geometries with **cross-ply** and **quasi-isotropic** layups are used.

Specimens with the **exact dimensions and layers** will be **used and compared** with the **experimental results**.



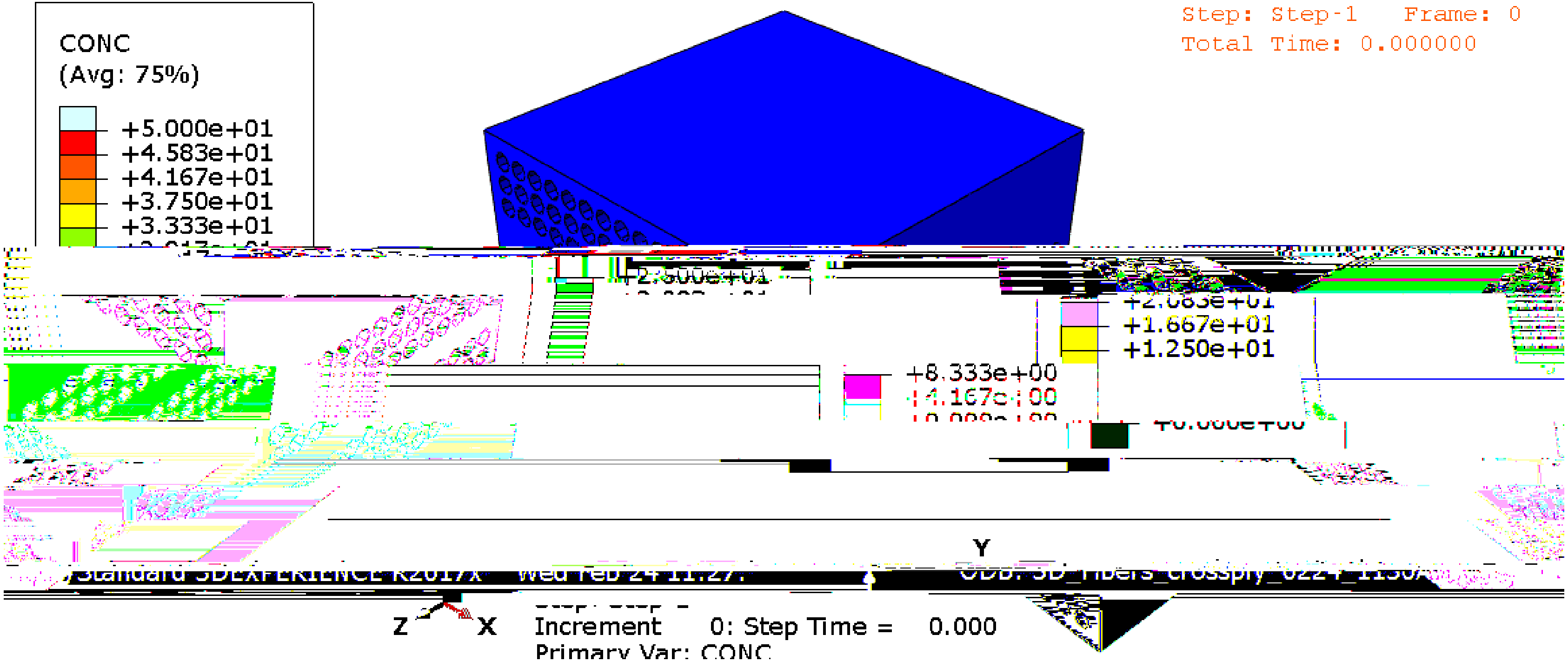
Cross-ply layup [0/90/90/0]



Quasi-Isotropic layup [0/-45/45/90]

Preliminary results

Animation for diffusion through a **cross-ply** specimen



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Preliminary Results: Fiber Array study

Hexagonal array appears to have a faster diffusion rate than square array.

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Technical Publications