Consolidation sensor framework for challenging material characterisation problems

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Importance of consolidation

1 - Importance of consolidation in defect formation (fibre path defects, resin defects, voids)

2 - Dimensional tolerances (5% of thickness)

3 - Consolidation is influenced by resin flow modes

4 - Interconnected processes and parameters
Characterisation process

Test scheme

Candidate models

\[ \frac{dh}{dt} = F(t, h) \cdot Q_1(h) \]

Model 1

\[ \frac{dh}{dt} = F(t, h) \cdot Q_2(h) \]

Model 2

\[ \frac{dh}{dt} = F(t, h) \cdot Q_N(h) \]

Model N

Training

Model for model training

Load schedule

Validation

Load schedule

Training response

The first example

| Model A | Experimental data noisy
| defgen.1 | RMSE 8.79e-04 |

| Model B | Experimental data noisy
| nsvc.pow | RMSE 5.39e-04 |

Validation response

The first example

| Model A | Experimental data noisy
| defgen.1 | RMSE 3.78e-03 |

| Model B | Experimental data noisy
| nsvc.pow | RMSE 3.47e-02 |
Two-step parameter extraction

Brute force step

Secondary optimisation
Data-rich testing programme

**Test setup**

**Training set options**

- Test 1
- Test 4
- Test 8
- Test 1
- Test 4
- Test 8
- Test 1
- Test 4
- Test 8

**Training / Validation**

Training

- Test 1
- Test 4
- Test 8

Validation

- Test 1
- Test 4
- Test 8

**Test cases**

- Test 1
- Test 2
- Test 3
- Test 4
- Test 5
- Test 6
- Test 7
- Test 8

**Graphs**

- Force vs. Time for Test 1, Test 4, Test 8
- Thickness vs. Time for Test 1, Test 4, Test 8
Conceptual design

Consolidation models library
- Flow model 1
- Flow model 2
- Flow model N

Consolidation sensor
- Process 1
  - Candidate model 1 try
  - Parameters set 1
- Process 2
  - Candidate model 2 try
  - Parameters set 2
- Process N
  - Candidate model N try
  - Parameters set N

Load schedule definition
- Consider several load schedule options
- Predict candidates feedback
- Pick option with maximum difference between candidates feedback

Compression machine
Thickness curve $h(t)$

Test example

Load schedule
- Current step
- Load option 0
- Load option 1
- Load option 2
- Load option 3
- Load option 4
- Load option 5
- Load option 6
- Load option 7
- Load option 8

Models ranking for current load step

Consolidation sensor

Candidate flow mode
- Candidate 1
- Candidate 2
- Candidate N

Candidates performance
- Candidate 1
- Candidate 2
- Candidate N
Thank you for your attention!

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