Active Thermal Management using the PtFS Process for Rapid Processing of Composite Structures

SPE Automotive
September 2013
THE CHALLENGE

Composites offer dramatic potential benefits but issues remain:

- Volume
- Variability
- Cost

- Cycle time - Takt
- Quality Assurance - QA
- Investment re-allocation
- Integration
- Whole life costing
WHAT WE NEED TO DO

- Pre-form.
- Lay-up.
- Infiltrate.
- Consolidate.
- Heat.
- Cure.
- Cool.
- Repair.
- Recycle.

Polymeric

Metallic

Ceramic

Material selection and format?
PROBLEM
## PROCESS COMPARISON

<table>
<thead>
<tr>
<th>Element</th>
<th>Induction</th>
<th>Steam</th>
<th>PtFS</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC/ABS Carbon (mins)</td>
<td>4</td>
<td>2</td>
<td>2 (1)</td>
</tr>
<tr>
<td>Tmax (deg C)</td>
<td>400</td>
<td>220</td>
<td>750</td>
</tr>
<tr>
<td>Active thermal management</td>
<td>N</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Tolerance (+/- deg C)</td>
<td>15</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Energy per component</td>
<td>~$0.08</td>
<td>?</td>
<td>$0.07 ($0.04)</td>
</tr>
<tr>
<td>License</td>
<td>Y</td>
<td>?</td>
<td>N</td>
</tr>
<tr>
<td>Royalty payments</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Data logging channels</td>
<td>2</td>
<td>2</td>
<td>16 - 32</td>
</tr>
<tr>
<td>Number of zones</td>
<td>2</td>
<td>1</td>
<td>16 - 32</td>
</tr>
</tbody>
</table>
WHAT WE OFFER

Self heated & cooled processing solutions for polymers & metallics with ........

- Active thermal management
- Pixelated control
- Digital NOT analogue
- Intelligent molding environment
- Adaptive & reactive control
- In-process Quality Assurance
INTEGRATED APPROACH

System of Systems

Turn-key or Retro-fit Conventional or Reconfigurable Mould Tool

Multi-channel, on-demand, fully variable heating & cooling

Real-time and Predictive control with multi-point QA capture

Plug & Play closed loop processing
AN INTEGRATED APPROACH

Compression molding cell

Heating & cooling rate 200 deg C per minute.
INTELLIGENT CONTROL

PtFS multi-channel control system

Active management of variable thickness part cure cycle.
## CASE STUDY 1

**Compression moulded PEEK**

<table>
<thead>
<tr>
<th>Element</th>
<th>Conventional</th>
<th>PtFS</th>
<th>Saving</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production type</td>
<td>Cell</td>
<td>Cell</td>
<td>-</td>
</tr>
<tr>
<td>Production cells</td>
<td>10</td>
<td>2</td>
<td>80%</td>
</tr>
<tr>
<td>Cycle (mins)</td>
<td>180</td>
<td>11</td>
<td>95%</td>
</tr>
<tr>
<td>Power (kW)</td>
<td>10</td>
<td>14</td>
<td>140%</td>
</tr>
<tr>
<td>Energy (kWhrs)</td>
<td>30</td>
<td>2</td>
<td>90%</td>
</tr>
<tr>
<td>Tolerance (+/- deg C)</td>
<td>5</td>
<td>2</td>
<td>40%</td>
</tr>
<tr>
<td>Pressure (MPa)</td>
<td>14</td>
<td>4</td>
<td>75%</td>
</tr>
<tr>
<td>Matrix volume fraction</td>
<td>38</td>
<td>32</td>
<td>16%</td>
</tr>
<tr>
<td>Data logging channels</td>
<td>4</td>
<td>24</td>
<td>-</td>
</tr>
</tbody>
</table>
POSSIBILITIES

Allows users to exploit real-time and forward looking analysis within the mould to make informed, in-process, localised decisions to derive additional component functionality e.g.:

- Correction of spring back.
- Localised promotion of adhesion.
- Control of crystallinity.
THERMAL CONTROL

Localised control

Multiple zones control material flow
LOCALISED CONTROL

Residual stress control

Sample 3 - 50mm  Sample 4 - 18mm  Sample 8 - 0mm
## CASE STUDY 2

Compression moulded PE foam

<table>
<thead>
<tr>
<th>Element</th>
<th>Conventional</th>
<th>PtFS</th>
<th>Saving</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work flow type</td>
<td>Line</td>
<td>Cell</td>
<td>-</td>
</tr>
<tr>
<td>Cycle (mins)</td>
<td>15</td>
<td>4</td>
<td>74%</td>
</tr>
<tr>
<td>Labour</td>
<td>2</td>
<td>1</td>
<td>50%</td>
</tr>
<tr>
<td>Energy (kWhrs)</td>
<td>4.5</td>
<td>0.5</td>
<td>88%</td>
</tr>
<tr>
<td>Number of moulds</td>
<td>20</td>
<td>2</td>
<td>90%</td>
</tr>
<tr>
<td>Floor space (m²)</td>
<td>200</td>
<td>50</td>
<td>75%</td>
</tr>
<tr>
<td>Data logging channels</td>
<td>1</td>
<td>32</td>
<td>-</td>
</tr>
<tr>
<td>PBIT (per $10.00)</td>
<td>$1.81</td>
<td>$4.68</td>
<td>258%</td>
</tr>
</tbody>
</table>
PERFORMANCE

Example

400 degrees C
@ +/-0.5 degrees C
240 seconds
SECTORS

The PtFS process supports thermoset & thermoplastic composites (... metals / glass) for end users in:

- Aerospace
- Automotive
- Defence
- Offshore
- Consumer Electronics
**CASE STUDY 3**

Resin Transfer Moulded carbon epoxy

<table>
<thead>
<tr>
<th>Element</th>
<th>Conventional</th>
<th>PtFS</th>
<th>Saving</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production type</td>
<td>Cell</td>
<td>Cell</td>
<td>-</td>
</tr>
<tr>
<td>Production cells</td>
<td>3</td>
<td>1</td>
<td>66%</td>
</tr>
<tr>
<td>Power (kW)</td>
<td>40</td>
<td>50</td>
<td>125%</td>
</tr>
<tr>
<td>Energy (kWhrs)</td>
<td>10</td>
<td>3.2</td>
<td>68%</td>
</tr>
<tr>
<td>Tolerance (+/- deg C)</td>
<td>5</td>
<td>1</td>
<td>80%</td>
</tr>
<tr>
<td>Control zones</td>
<td>4</td>
<td>60</td>
<td>-</td>
</tr>
<tr>
<td>Data logging channels</td>
<td>4</td>
<td>64</td>
<td>-</td>
</tr>
</tbody>
</table>
SUMMARY

Integrated production solutions provide:

- **Rapid ramp rates** - 200 deg C / min to 750 deg C.
- **Precise surface control** - +/- 0.5 deg C.
- **Energy & Cycle time reduction** - 95%.
- **100%** feedstock material utilisation & local cure e.g. Nylon panel.
- **100%** ‘transparent’ in-process Quality Assurance.
- Guaranteed Production to Functional Specifications - PtFS.

**but............

- **Whole life cost.**
- **Organisational change.**
THANK YOU FOR YOUR TIME

QUESTIONS?

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- e-mail: info@surface-generation.com

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