A Continuous Process for Hydro-Stitching Fabrics
Kyle Joynes, Monét Freeman, Mitchell Bost, and Tyler Reiss
April 23, 2014

### Introduction

**What is hydro-stitching and why is it important?**

<table>
<thead>
<tr>
<th>Hydro-stitching:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site specific bonding of fabrics using high pressured water</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Motivation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Innovate new process for seam formation</td>
</tr>
<tr>
<td>• Save nonwovens industry time and money</td>
</tr>
<tr>
<td>• Find results for optimal bond strength</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Advantages:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Pore size the same as filter</td>
</tr>
<tr>
<td>• No damaging of fiber or introduction of adhesive</td>
</tr>
<tr>
<td>• Easily added to nonwovens manufacturing line</td>
</tr>
</tbody>
</table>

---

### Prototype

**Main Components**

- Black steel frame
- Pump
- Jet strips
- Orifice and stitching manifold
- Silver t-slotted aluminum frame
- Screen mesh table
- Slide bearings
- Hand brakes
- Winder and unwinds

**Prototype Reiteration**

- Single/double jet nozzle
- Use less-entangled polyester (PET) fabric to achieve stronger stitch
- Properly tension mesh screen
- Readjust tension rollers
- Fix speed and nozzle diameter
- Set up DOE
- Obtain optimal stitching parameters

---

### Project Objectives

**Sponsor Requirements**

- Establish appropriate winder or roller system for continuous application.
- Create seam between two fabrics without use of foreign materials or damaging fibers.
- Examine bonding strength of the material to ensure the seam is sufficient for filtration products currently being used.
- Refine the process to be comparable to other traditional seam forming methods such as ultrasonic bonding.

---

### Project Results

**Design of Experiments**

- Distance from nozzle to fabric: Distances range from 2-4"
- Pressure of water: Pressures range from 1000-3000 PSI
- Number of nozzles: 1 or 2 nozzles
- Nozzle diameter and speed are fixed

**Pressure**

- Pressure is the only significant factor with a P-value < .05

---

### Conclusions

- Pressure range was too low to conclude optimal stitching parameters
- Highest strength: 3000 PSI, 2 in, 2 nozzles
- Able to create controllable, continuous method of stitching fabric with high pressured water

**Future Work**

- Using competing methods, bond PET and compare tensile strength to hydro-stitching
- DOE with pressures ranging from 3000-4000 PSI
- Analyze effect of sequential machine direction jet impact forces

---

### Competing Technologies

<table>
<thead>
<tr>
<th>Bonding Method</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydro-Stitching: Site specific bonding of fabrics using high pressured water.</td>
<td>No addition of chemicals or binders</td>
<td>Slower production speeds</td>
</tr>
<tr>
<td></td>
<td>Pore size the same as fiber</td>
<td>Low material versatility</td>
</tr>
<tr>
<td></td>
<td>No damage of fabric or fibers</td>
<td>Often requires additional drying</td>
</tr>
<tr>
<td>Stitch Bonding: Materials are joined by one or more threads through a foundation of stitches.</td>
<td>Large versatility in materials used</td>
<td>Slower production speeds</td>
</tr>
<tr>
<td></td>
<td>Higher seam strength than ultrasonic and chemical bonding</td>
<td>Requires the use of thread and needles</td>
</tr>
<tr>
<td></td>
<td>Available for consumer use</td>
<td>Damages fabric in and around seam location</td>
</tr>
<tr>
<td>Ultrasonic Bonding: Uses high frequency vibrational energy to melt fibers &amp; form bonds between thermomelt polymers.[6]</td>
<td>Higher production speeds then stitch bonding</td>
<td>Requires thermoplastic polymers to bond</td>
</tr>
<tr>
<td></td>
<td>Strong seal without the use of adhesives or staples</td>
<td>Large start-up cost</td>
</tr>
<tr>
<td></td>
<td>Uniform bond</td>
<td></td>
</tr>
<tr>
<td>Chemical Bonding: Gluing fiber intersections with a binder adhesive. [7]</td>
<td>Higher speeds</td>
<td>Requires the use of binder</td>
</tr>
<tr>
<td></td>
<td>Easy application</td>
<td>Not chemically clean</td>
</tr>
<tr>
<td></td>
<td>Can virtually bond any textile materials</td>
<td>Often requires additional drying</td>
</tr>
</tbody>
</table>

---

### Sponsorship & Acknowledgements

**The NC State Nonwovens Institute**: Dr. Behnam Pourdeyhimi, William Barnes, Steve Sharp, Benoit Maze, Angela Carmo, and Ali Bagheri (Master Thesis)

**Senior Design Faculty Mentors**: Dr. Russell Ganga, Dr. Jon Rust & Dr. Jesse Jar

---

### References

7. Nonwovens Institute Features: http://www.thenonwovensinstitute.com/about

---

**TE/TI Senior Design 2013-2014**