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P17221 Composite Winder Ideas for the Future

Preface

While the team at large is proud of the success we had in producing a strong single layer tube, we also feel that the machine requires several upgrades and has a lot of potential for improvement. This makes it a good candidate for a follow on project.

To describe the machine in simplest design terms, the winder was physically constructed and is extensively defined in the software ComposiCAD. Any changes to the dimensions of the machine or to the motor systems needs to be appropriately updated in ComposiCAD. A list of defined variables in ComposiCAD is below:

- Movement
  - Mandrel Speed; Mandrel Acceleration
  - Cross-Carriage Speed, Cross-Carriage Acceleration
  - Feed Rate
- Dimensions
  - Maximum Part Size
  - Payout Eye Distance (under envelope settings)
- Part Details
  - Part length, Part Diameter
  - Headstock/Tailstock Length
  - Wrap Angle
  - Fiber Width
  - Motor speed/acceleration % (under lamina output options)

These physical constraints drive the performance and geometry of the machine. As is the nature of working without feedback loops, any slip of either motor results in a complete failure of part production. This has been the largest struggle of the project. The list on the next page contains details about several problem areas and possible upgrade ideas.

This playlist contains footage of the machine in operation from several different angles, for reference:
https://www.youtube.com/playlist?list=PLRmveTf9Ug1jm8oHruqxysIKlxqIoZJ4q

Problems

1. Crossfeed Motor
    a. The motor is not suited to handle the current required for it to move the crossfeed under tension @ 45 degree WA (wrap angle) without overheating.
    b. The motor must be strong enough to overcome dynamic loads associated with spikes in tension and changing direction, as a single slip can ruin the current wind.
    c. The pulley opposite the end of the motor may need to be overhauled as the assembly already bends under the current belt tension.
2. Tow Tension Consistency
    a. This refers to the nature of the tensioning system and the fact that the output tension varies as the spool of CF unwinds. Different angles from the spool to the payin eye cause different tension.
    b. The team did use standoffs to center the spool with respect to the payin eye but that didn't completely solve the issue.
    c. Due to the approach the team took towards tensioning it's difficult to solve the issue with the current implementation.
    d. There a lots of possible solutions and this area could certain use the most innovation.
3. Operator Safety
    a. There is a fair amount of wire exposure especially concerning the connection to the power supply units.
    b. This is a priority item that we didn't complete. This area should be enclosed before the customer uses it.

Upgrades

1. Payout Eye Rotation
    a. The tow path through the payout can impact the tow width due to the spread of the fibers. In industry the best solution is to have a rotating payout eye controlled by another motor.
    b. The Arduino has the capacity to support another motor.
    c. The ComposiCAD license also supports this axis of rotation.
2. Resin Delivery
    a. The current resin bath implementation mitigated the risk of getting resin on vital components (electronics, crossfeed slide) but a lot of resin drips from the payout eye and from the mandrel.
    b. In general, too much resin gets delivered to the mandrel.

    c. Ideally, a solution will lower the resin content of the part, improving strength to weight performance while making the whole production procedure cleaner.
    d. The resin bath size should not be increased much further due to concerns related to exotherm
3. Tailstock/Drive Fit and Finish
    a. The spindle that the chuck threads into is slightly undersized compared to the the bearing ID. Results in radial play of entire headstock.
    b. Drive tensioning roller does not incorporate a bearing, causes significant wear on belt. Tensioning brackets are oversized as well.
    c. Tailstock needs a handle for the quill.
4. Guarding
    a. Guards for the electronics to prevent damage; cover exposed wires.
    b. Guards for drive belt and associated pulleys because of pinch points.