VDR3: T513 Automated Shaft Flux Measurement Device

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Danfoss uses magnetic blade shafts to reduce friction in their compressors. To ensure the shafts are production ready, Danfoss performs a ‘check’ on their shafts by manually measuring the magnetic flux density, via a fluxmeter, for several thousand spots on the magnetized region. This method has proved to be unreliable and labor intensive. The objective of this project is to design an automated flux reader (AFR) to obtain the measurements and analyze the data. In theory, the magnetic flux will remain constant along each axial line that corresponds to the circumferential increment. The automated flux reader will be used to detect and flag any significant deviation in the magnetic flux readings.

Currently, Team 513’s design is in the prototyping process. The team has been researching various tabletop lathes as well as non-magnetic materials that could be used when deconstructing and reconstructing the lathe to better fit the needs of the design. The team has also been researching motors that would work to operate the power gear separately from the shaft housing. MATLAB and Creo are also being used to test and measure the integrity of the device as well as the amount of power required to increment through the preset locations. Team 513 is also looking to design a mechanism for the sensor probe to protect it from damaging through constant use while ensuring that constant and light pressure is maintained for each measurement. For other components such as the chuck head, constructive advice was taken and a new design containing a centered anchor point is being implemented to mitigate room for human error.

Looking forward towards the Spring 2024 semester, there is still a substantial amount of work needed to be done in order to ensure a successful project. A major step ahead for Team 513 is to begin purchasing all of the materials and components needed for the project listed in the bill of materials. After getting approval and finalizing the budget, the process of machining and assembling the actual automated flux measurement device will start. This is where the team will machine the aluminum body of the device and attach the components such as the lathe chuck head and live center used for securing the shaft. After completing the assembly of the hardware for the device, the next step will be to create the open-source code ran by the Arduino that is able to complete the testing procedure while also collecting and transferring the data to a spreadsheet on another separate computer. Once the hardware and software has been completed, one of the final steps will be to complete extensive testing of the device to ensure it meets the team’s key goals and is ready for Danfoss to take delivery of it. Lastly, an operation manual will also need to be created to give to the future operators at Danfoss. Engineering design day is in early April so that means the team will only have about three months to work and therefore must get to work as soon as possible. Also, like with any design process, there will be unexpected setbacks so Team 513 must be prepared for them and try to stay ahead of schedule. This way the team does not have to hurry to complete our project right before the deadline.

Planning ahead, Team 513 recognizes areas of risk in the upcoming stages of design. Of note, there is a tolerancing risk in using the live center of a lathe that could interfere with the end of a compressor shaft. This issue could impact the securement and the alignment of the shaft. The VT series shafts are machined with a taper on the ends for similar securing process used for various machining and testing processes at Danfoss. Given the high tolerancing standards used in these other various processes but also determining there could be further unforeseen problems with such interfacing with the AFR; Team 513 believes attempting to utilize a direct interface between the shaft and live center is a worthy course of action. But as proposed the use of threaded and tapered inserts could be installed to improve alignment if other issues come to arise. Ultimately, Team 513 intends to stay vigilant and is prepared for challenges to come.