Senior Desing Project #8

Danfoss Turbocor:
Stator Insertion Machine Redesign

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Needs Assessment

Time and florr space are both valuable resources in manufacturing, thus saving time and freeing up floor room saves the company money and facilitates production flow. Currently stator housings are heated four at a time in a large oven which is expensive and slow to run. Due to high component temperature, the technician is required to wear asbestos gloves to handle the housing. The fact that only four are heated at a time means the rest of the production floor has to wait for the process to complete. A more efficient, faster heating and insertion method is desired to increase production speed.

Project Scope

Problem Statement

Design a more efficient way of heating the aluminum housing for stator insertion. Once the housing is heated the outside surface should be easily handled without needing excessive protective equipment. The heating and insertion process should be completed in a timeframe to allow increased production. The finished product should be considerably smaller than the current heating equipment.

Objective

Construct a heating element, powerful enough to sufficiently heat the housing to insert the stator. This whole process should be completed in less than 8 minutes. The exterior of the heated housing should not exceed 200 degrees Fahrenheit. The final device should not exceed 3 square feet by 6 feet tall.

Justification and Background

Danfoss Turbocor makes state of the art compressors that utilize magnetic bearing technology. One of the key steps in manufacturing the compressor is inserting an oversized stator into an aluminum outer casing. The stator is held in place using an interference fit. Batches of housings are loaded into a large electric oven four at a time. The parts are then heated for approximately thirty minutes. Once the stator is inserted the part must cool for a long time before workers can continue assembly. The batch method of heating does not allow for rush orders to be completed in a timely manner. This section on compressor assembly requires extensive floor space that could be used for other manufacturing processes.

Placing the entire housing into an oven exposes all surfaces of the housing to direct heat. This method makes the entire housing very hot and difficult to handle. Heating the inside of the housing will allow significant thermal expansion of the housing while keeping the exterior surfaces at a low enough temperature to be handled by the operator. Heating

the interior turns this process into a transient heat conduction problem. The temperature of the body will be a function of variation in three directions through the body as well as time. Heat will be introduced to the internal surface of the housing. Some heat is stored within the system while heat will be lost by convection through the exterior of the body. The coefficient of thermal expansion describes how the size or volume of a material changes with a variation in temperature. A key element of this project is to find the necessary minimum housing temperature to fit the maximum size stator into the housing.

Two methods to achieve localized heating are resistive heating and inductive heating. Resistive heating uses electric current to release heat. Current is passed through a conductor. Inductive heating allows heating a material by electromagnetic induction. These two techniques will be investigated to determine the more efficient method.

Methodology

The first step in this project involves using the expansion coefficient to determine the temperature needed to expand the housing enough to fit the stator. The maximum material condition is used for the housing and the stator. A good understanding of heat transfer and interference fit tolerancing will be required. The second phase of the project is determining the amount of heat needed to raise the housing temperature to the determined value. Temperature probing location and method needs to be determined. The last part of the project is deciding on the method of heating. Research will need to be done on new materials that transfer heat efficiently. Several experiments will be performed throughout the project. Once the temperature is determined we will need to verify that the parts fit together. Accurate temperature probing will need to be tested to ensure repeatability of the process.

Constraints

The final product must provide repeatability so that it could be implemented in production.

Heating element must operate on a standard wall outlet.

Wear items in the system need to be commercially available to reduce down time of the system.

Expected Results

At the completion of the project, the design should be able to complete this cycle of thermal fitting parts reliably and efficiently. The finished product will be implemented in actual production of compressors at Danfoss Turbocor.