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CAMPUS-WIDE NITROGEN SYSTEM CAPABILITY MODEL

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ABSTRACT

This paper presents the development of a simulation project to examine the effect of autoclave usage on a campus-wide nitrogen system for a Tier 1 AeroSystems supplier. The concern, in particular, was the addition of the Assembly Support Building (ASB) autoclave installation for a new production program and the effect the autoclave would have on the campus-wide nitrogen system. The nitrogen system, currently supporting 19 autoclaves, utilizes membrane nitrogen generators to produce the gas and uses vaporized liquid nitrogen to supplement the system when there is a deficiency to maintain the required system pressure. The Simulation/Decision Support group was contacted to determine insight to the anticipated nitrogen consumption and to provide an analytical tool for the future dynamic business model at this plant.

1 INTRODUCTION

The campus-wide nitrogen system is comprised of three basic elements: supply, storage and distribution. The supply element contains four membrane nitrogen generators and a liquid nitrogen storage tank. The nitrogen from the generators is pressurized by three compressors rated at 500 psig *(pounds per square inch gauge)*.

The storage element contains compressed vapor nitrogen in three locations: Plant 2, CMF, and IPB4. The total existing vapor storage capacity is approximately 60,900 cubic feet. Liquid nitrogen is stored in three tanks. The combined volume of the tanks is 39,000 gallons or approximately 3,600,000 standard cubic feet (SCF).

The system operates as follows: the autoclaves are typically operated at pressures of 45 psig, 60 psig or 90 psig, depending on the profile or recipe required by the loaded production parts. The autoclaves are purged and filled with nitrogen to the full required operating pressure in approximately ten to fifteen minutes. Upon filling the autoclaves with nitrogen, the campus-wide nitrogen system pressure *(whose maximum system pressure is approximately 500 psig)*, drops based on the amount of nitrogen required by the draw. After the autoclave draw, the membranes and compressors attempt to refill the nitrogen storage system and recover the system pressure drop. This refilling operation continues until another autoclave draw occurs or the system maximum pressure is achieved. If, however, the autoclave usage is heavy enough to drop the nitrogen system pressure below 200 psig, liquid nitrogen is introduced into the system to keep the pressure from dropping further. This is accomplished by vaporizing the liquid nitrogen. When the system pressure achieves a 200 psig level and no other autoclave draw occurs, the membrane/compressor equipment is activated in an attempt to recover the system to maximum system pressure. This cycle occurs until another autoclave draw event or maximum system pressure is achieved.

The objectives of this study were to develop and validate a model of the current campus-wide nitrogen system using AutoMod software, based on historical autoclave usage, within the decision-making time constraints of the project. Additionally, the model was used to evaluate the effects of the Assembly Support Building (ASB) autoclave on the nitrogen system relative to nitrogen usage and system pressure, and the six additional 7,000 cubic feet nitrogen storage tanks that were proposed by our Facilities organization.

2 MODEL

2.1 Methodology

The autoclaves and their associated calculated volumes were calculated. State variables, such as system temperature, density, weight, pressure and standard cubic feet (SCF) of nitrogen, were computed on a discrete-event basis.

2.2 Scenarios

Several scenarios were run to examine the effects on the nitrogen system.

- **Scenario 1** (Current System Configuration)
- **Scenario 2** (Current System With The ASB Load Cycle)
- **Scenario 3** (Current System With The ASB Load Cycle + ASB Nitrogen Storage Tanks)
- **Scenario 4** (Current System With The ASB Load Cycle with an Improved Recovery System)

3 RESULTS

- **Scenario 1:** The Actual Liquid SCF vs. the Calculated Liquid SCF are within 1.6% of each other (Model Value = 1.6% less than Actual Value). The reasonability check concluded the Estimated Gas Recovery vs. the Model Gas Recovery was within 4.6%.
- **Scenario 2:** Liquid SCF now accounts for 11.5% of total gas usage, as compared to 2.2% total usage in Scenario 1 (no ASB autoclave).
- **Scenario 3:** Liquid SCF now accounts for 4.6% of total gas usage, as compared to 11.5% total usage in Scenario 2.
- **Scenario 4:** System pressures show a noticeable improvement due to the improved nitrogen system recovery capability (1.5 x current rate). Liquid SCF now accounts for 0.14% of total gas usage, as compared to Scenarios 2 and 3.

4. CONCLUSION

At the time of this study, liquid nitrogen costs were roughly 10 times the cost of nitrogen generated from membranes/compressors and should be minimized. The cost of installing gas storage tanks is considerable; therefore, a good return should be gathered from their installation. This model can used for decision-making purposes and can be updated, as needed.

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