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Redesign of the RBS Filtration System

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Executive Summary

The RBS Filtration System has existed in one form or another for many years but rarely seen manufacture due to its poor performance and visually unappealing form. The unit's original design consisted of a main shell housing a long, reverse-axially formed wedge wire screen, an equally long air cylinder with mounted plunger, and assorted headers. The system was designed to allow automated cleaning upon detection of a set differential pressure drop from inlet to outlet using a backwash sequence, but experienced several technical difficulties resulting in the product's abandonment. The aim of this project was to address these problems through modification to the plunger system. Numerous iterations were devised to improve understanding of these issues and possible viable solutions. A short round of testing was conducted on two plunger designs but the majority of testing (see Sections 5.0 and 6.0) has yet to be performed.

In addition to the plunger designs, numerous iterations of a newly proposed auger system were designed including both the augers themselves and the surrounding structure. An initial auger was fabricated to discern the problems with constructing the component. Following this a testing vessel for the auger was designed but did not see fabrication due to time constraints.

Ultimately what was learned was that new forming techniques must be developed to allow for the fabrication of the auger's flighting. The current method is ineffective at creating the desired outer diameter, a crucial aspect of an effective auger. It is recommended that testing begin on the assorted plungers and augers with the information gather being used to improve upon and finalize the new system.

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1.0 RBS Filtration System

1.1 Description

The RBS Filtration System is comprised of a large tubular shell containing a drum shaped wedge-wire basket with an upper to lower inlet/outlet design. It incorporates a large air cylinder and plunger for use in backwash automated cleaning system. The unit serving as the focus of this report, a 200-3", is built to withstand an internal pressure of 150 psi and operating temperature of 150 °F (65.6 °C).

The screen is cleaned through a dual backwash-plunger system. This process is triggered by the connected PLC when the differential pressure between the inlet line and outlet line passes a preset threshold. The vessel, already filled with liquid, has the basket's inner diameter scraped by the plunger head, displacing the retentate clogging the open area of the screen. At the same time the backwash valve opens to a zero gravity drain, allowing the solids now suspended in the liquid medium to be removed from the vessel. The differential pressure is checked again and if it has returned to a suitable level normal operation proceeds; if not, the vessel is refilled with liquid and the process is repeated until it is acceptable.

The primary issue during the backwash procedure is the plunger fails to displace significant waste from the basket. The plunger frequently jams on the down stroke, preventing it from effectively removing the retentate and restoring the system to an acceptable differential pressure. The plunger/air cylinder combination also fails from an aesthetic and spatial standpoint, with a visually unappealing exterior and the air cylinder greatly increasing the space required for the vessel.

This problem was approached in a variety of ways which will be outlined in this report with an analysis of some of the strengths and weaknesses of each design.

1.2 Acceptance Criteria

The new design must perform at a higher level than the original; reduced downtime, more effective cleaning, and a space-conscious approach are essential. Additionally cost, ease of maintenance, and overall robustness must be factored into the design to further improve the product line. Finally, the solution developed must be scalable between the various models sizes.

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2.0 Initial Design Iterations

2.1 Overview

Prior to the first design evaluation there were seven designs conceived and fully modeled (excluding the original design) with four additional augers designs not integrated into the vessel's body. The original represents the design in its state at the start of this project with no alterations made, and the seventh a testable model based on Iteration 5 to generate data for this report. The proposed new iterations, first through sixth, are:

A. Basic Auger
B. Triple Scraper
C. Hollow Auger with Supports
D. Auger with Helical Brushes
E. Triple Air Cylinder
F. Perforated Auger

2.2 Iteration Details

a) The Basic Auger (see section 3.6.1) provides the new vessel configuration for the remaining iterations, shortening the main shell, introducing a slip-on and blind-flange, and adding an additional leg to the support structure. The main feature is the auger and associated structure, which under motor power is designed to remain flush with the basket surface while scraping off built up waste.

b) The Triple Scraper (see Section 3.6.2) works with the same shell configuration as Iteration 2, but with a modified primary cleaning system. Rather than an auger there are three straight brushes mounted to a motor-driven shaft that rotate to scrape the inside of the basket.

c) The Hollow Auger with Supports (see Section 3.6.3) operates identical to the basic auger with the difference being in the design of the auger. Rather than having the flighting spanning the basket to the shaft, it is instead a one inch wide plate helically bent around the shaft. It is then supported by nine crimped pieces of pipe.

d) The Auger with Helical Brushes (see Section 3.6.4) is similar to the previous iteration but rather than maintaining contact with the basket through tightly toleranced formed plate, it uses interference from a brush welded to a helical support structure.

e) The Triple Air Cylinder (see Section 3.6.5) is the closest in concept to the original design, but is intended to overcome some of its associated problems. It features three air cylinders rather than one to improve both the stability of the plunger as it moves and the power behind it to reduce hang-ups. It also utilizes a circular brush to improve contact with the basket and make

replacement simpler.

f) Finally, the Perforated Auger (see Section 3.6.6) is similar to the Basic Auger with the exception of the plate used for the flighting being perforated rather than regular plate. This is meant to improve flow through the chamber and make it easier for waste to move down and out the backwash pipe.

[Remainder of report has been omitted]