RADWASTE FLOOR DRAIN FILTER REPLACEMENT

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ABSTRACT

The floor drain etched disc filter is a relatively new radwaste filtering/disposal unit employed in the commercial nuclear power generation environment. Until recently, the previous Monticello radwaste floor drain filtering system required large amounts (20 to 30 Kg per run) of precoat material to process 3 l/s streams of radwaste normally containing 50 to 200 ppb suspended solids. The new filtering system uses approximately 0.5 Kg per run and achieves filtering runs anywhere from 10 to 50% to longer than its predecessor based upon existing influent water quality. Over the long run, this continued performance will enable the plant to realize significant savings in disposal costs. The installation of the etched disc filter was completed without significant revisions to the existing vault and piping. The quality of the filter's effluent (measured in suspended solids) is approximately equal to that achieved by its predecessor.

INTRODUCTION

The etched disc floor drain filter, manufactured by VACCO Industries, processes waste streams from various sumps and miscellaneous collector tanks located throughout the reactor and turbine buildings. The materials held in these sumps and tanks are comprised of waste streams containing dissolved organics, suspended solids and other waste materials.

These waste streams are pumped through an extensive piping network (Fig. 1) to the radwaste pump room and eventually into the vault where the etched disc filter is located. The vault (Fig.2) is a concrete encasement designed to provide protection against radiation levels approaching 2 Roentgens per hour during waste water filtering and backwashing operations.

The filtration process removes suspended solids and other foreign matter down to five (5) microns. When a predetermined differential (d/P) pressure across the filter is reached, the filter is backwashed. The backwash operating mode provides a mechanism whereby the filter cake material is removed from the filter elements via a "slug" of 2413 KPa air first and then by a clean water wash second. The waterwash effluent containing the de-caked material is transferred to a waste sludge tank and then held for further processing.

Filter Components

The primary elements of the filter system are the etched disc filter vessel and elements, backwash receiving tank and an air accumulator tank, which functions as a surge vessel containing 2413 KPa air for the backwash cycle. These components were designed for skid mounting and installation into the existing filter vault. The ancillary components are comprised of a two-stage air compressor, several on/off valves and pressure/level switches, which provide discrete inputs to a dedicated Gould/Modicon 884 Programmable Controller (PC) (Fig. 3). This PC, which replaced a mechanical Taylor barrel and contact controller, sequences the backwashing/precoating of the filter elements (when in the automatic mode) after a predetermined differential pressure across the filter is reached. Several pressure relief valves are located throughout the filter system, notably on the backwash receiving tank, the air accumulator tank and the filter's discharge line.

Filter Elements Description

The filter processes floor drain waste streams through a series of stacked etched discs (approx. 800 in number per stack). There are five (5) stacks located inside the filter vessel arranged in a circular pattern.

The technical merits of this particular filter as compared to its predecessor are based upon the filter element's etched disc design and fabrication. The disc is 0.254 mm in thickness and its shape approximates that of a central disc (6.35 cm diameter) with several small, finger-like projections (3.18 cm length) attached around the periphery of the disc (Fig. 4). Each finger contains a small, chemically etched area with a predetermined flow pattern, the pore size of which is identical to the required micron rating. A complete filtering unit is comprised of these individual elements stacked together (45.7 cm high), etched surface against non-etched surface to insure flow thru the etched pores only; the flow paths extend from the discs' outer edge to the inner edge. This design is conducive to lowering the d/P through the disc with a concomitant amount of precoat added prior to filtering. Thus, the d/P reduction across the filter elements is essentially achieved via a synergistic effect between the disc element design and the precoat material. As the filter cake's thickness

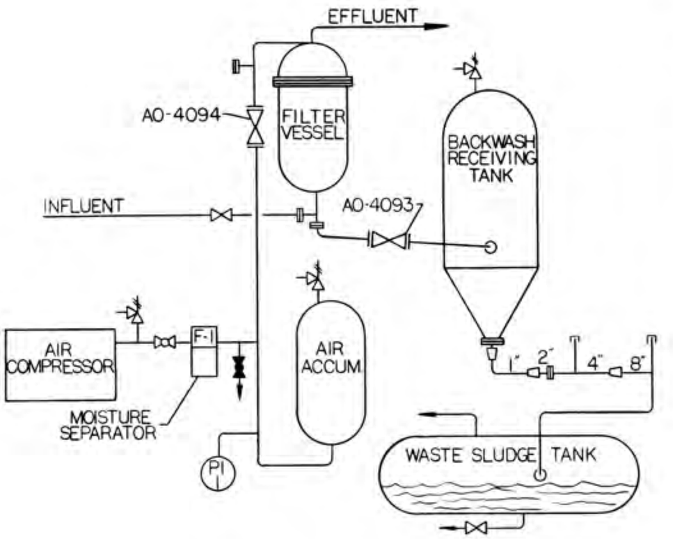

Fig. 1. Flow Diagram.

Fig. 3. Programmable Controller.

Fig. 2. Filter Located in Vault.

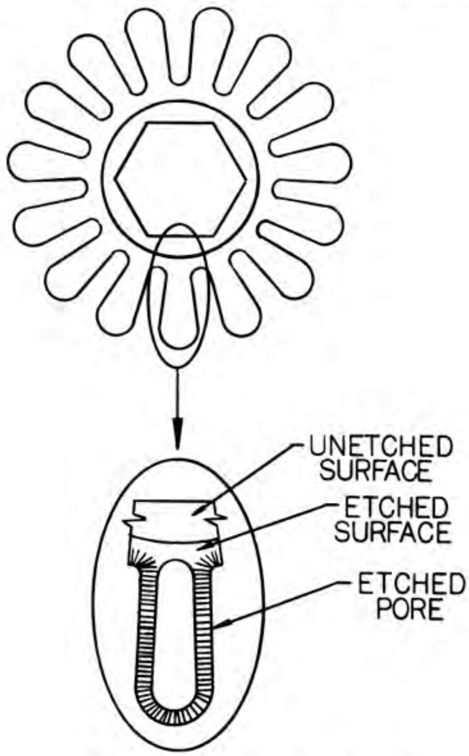

Fig. 4. Etched Disc Element.

increases with time, the d/P across the filter elements and cake reaches a level where the backwashing mode is automatically initiated to de-cake the filter. This predetermined level has been programmed into the PC at 345 KPa.

Filter Operations

During the filter backwashing, the filter stacks are exposed to a "slug" of 2413 KPa air to de-cake the filter elements and then to a clean water wash to remove remaining residue material attached to the filter stacks and inside walls of the filter vessel. After this operation, the water wash containing the de-caked material is transferred to a receiving tank via the 2413 KPa air. Subsequently, this wash material is transferred to an API rated sludge tank, rated at 15.2 cm water column (wc). Following the completion of the backwash, the PC restores the filter to its normal filtering operation until such time as the 345 KPa across the filter is detected by the PC; the backwash cycle is then again repeated.

Moreover, the amount of precoat required to accomplish the filtration is significantly less than previously required with the original system (approx. 1/50 as much per run.

Pressure Considerations

As mentioned in the previous section, the backwash effluent is eventually transferred to a 15.2 cm wc rated sludge tank via a 2413 KPa air "slug". The imposition of the aforementioned pressure constraint imposed by the sludge tank's pressure rating, necessitated the reduction of the air "slug" pressure from 2413 KPa leaving the receiving tank to a level below that to which the sludge tank could safely operate, that is, 15.2 cm wc. This was accomplished through the installation of an orifice in the discharge line from the receiving tank. The rationale underlying the continued use of the waste sludge tank stemmed from an operational viewpoint, that is, the ability to process waste streams through existing equipment, keeping disruptions to the ongoing radwaste operations to a minimum during the installation of the new filter system.

Vendor Testing

Prior to the actual purchase of the etched disc filter system, a series of pressure tests were conducted at the vendor's site (TTI) on a simulated system. The tests were performed to ascertain the filter system's capability to operate within the pressure limits imposed by the waste sludge tank utilizing a 2.54 cm orifice in the receiving tank's discharge line. Referring to Fig. 5, the graph indicates the initial pressure "spike" inside the the waste sludge tank following the backwash effluent discharge from the receiving tank to be on the order of 2.54 cm wc with subsequent pressure decay down to zero. Given the pressure constraint of 15.2 cm wc on the waste sludge tank, the 2.54 cm orifice was judged to be more than adequate in reducing the air pressure to an acceptable level.

Filter Installation

The filter and related components were designed to be skid mounted for ease in placing the system into the existing vault. The original filter, which had been removed earlier, went through decontamination and shipped offsite for disposal.

The engineering design embraced by the plant and the Nuclear Engineering and Construction group allowed the new filtering system to be installed without disrupting the ongoing plant operations to any significant degree. This was essentially achieved by adoption of a design mentioned in the first paragraph and also utilizing much of the same piping, valves, etc. that could safely be salvaged and reused.

Revision of the existing panelboard (located in the radwaste control room) was made to accommodate the installation of the new Gould/Modicon PC. Revisions included new limit switches and lights, pressure gauges and front panel mimicry. The PC was housed in back of said panelboard (Fig. 6).

Pre-Operational Testing

Following the construction phase of the project, the system was put through a pre-op testing program. One area that was given special attention was the evaluation of the 2.54 cm orifice located in the backwash receiving tank's discharge line to achieve the necessary pressure reduction exhibited in the vendor simulator runs. Several reasons for doing this were made apparent prior to drafting the pre-op test procedures: first, the plant required evidence that the newly installed filter system would not adversely affect existing filtration operations while functioning under actual plant conditions, primarily from a safety standpoint. Secondly, the TTI testing employed a 2.54 cm orifice; this size was judged by the system engineer to potentially cause problems in that larger sized particulate matter and suspended solids in the backwash effluent may eventually plug a 2.54 cm size opening. Completion of the pre-op testing indicated that a 5.1 cm orifice would produce a pressure "spike" inside the waste sludge tank to less than 10.2 cm wc, well within the stiplutated pressure rating of the sludge tank (15.2 cm wc).

Economic Analysis

Aside from the technical merits of this particular filter, the project economics revealed the following:

- A significant savings in waste disposal costs is projected over the assumed life of the filter. Given the rapidly escalating disposal costs (5 to 15% per year), the reduced amounts of wastes generated should translate into thousands of dollars of savings over the next two years alone.

- A project benefit/cost ratio (B/C) of 2.3 has been calculated based upon the data used to generate the projections enumerated above.

- A break-even point of 6 years, based upon a minimum rate-of-return of 14% has been computed.

Results

During the pre-operational testing phase of the project, the filter exhibited run-times 10 to 50% longer than the original filter system. The quality of the filter effluent streams (based upon level of suspended solids) is of the same magnitude as the original filter system. Approximately 1/50 as much precoat material was required to achieve the aforementioned effluent quality compared to that required by its predecessor.

The filter system is presently being put through additional tests to determine optimum levels of precoat, etc.

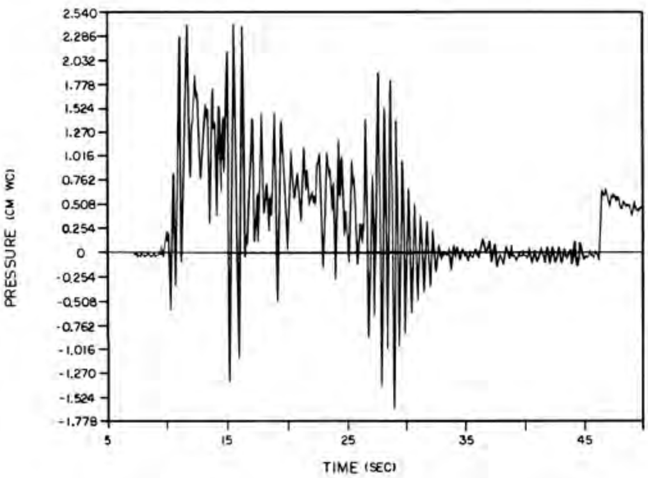

Fig. 5. Waste Sludge Tank Test Pressure.

Fig. 6. Panelboard.

SUMMARY

The new etched disc filter system was easily adapted into the existing confines of the radwaste vault without interrupting ongoing plant operations.

Preoperational filter operations have shown longer run-times vis-a-vis its predecessor while employing greatly reduced amounts of filter precoat material.

Significant cost savings during the operation of the new filter system have been projected as a result of decreased usage of precoat material, reducing the amount of waste materials to be disposed.

The inclusion of a new programmable controller has made the filter operation more operator-friendly and reliable. Moreover, the filter system is more amenable to troubleshooting if breakdowns do occur.