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Installation of the Pulse-Plate Column Pilot Plant

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1. BACKGROUND

There are three primary types of solvent extraction equipment utilized in the nuclear industry for reprocessing of used nuclear fuel; pulse columns, mixer-settlers, and centrifugal contactors. Considerable research and development has been performed at the INL and throughout the DOE complex on the application of centrifugal contactors for used fuel reprocessing and these contactors offer many significant advantages. However, pulse columns have been used extensively in the past in throughout the world for aqueous separations processes and remain the preferred equipment by many commercial entities. Therefore, a pulse-plate column pilot plant has been assembled as part of the Advanced Fuel Cycle Initiative to support experimentation and demonstration of pulse column operation. This will allow the training of personnel in the operation of pulse columns. Also, this capability will provide the equipment to allow for research to be conducted in the operation of pulse columns with advanced solvents and processes developed as part of the fuel cycle research and development being performed in the AFCI program.

2. SYSTEM DESCRIPTION AND OPERABILITY

A schematic of the pulse-plate column pilot plant is shown in Figure 1. The pulsed-plate column pilot-plant is constructed of 2.0 inch ID glass laboratory pipe manufactured by QVF. The column is housed in and supported by P1000 Unistrut® metal framing and associated fittings and is suspended by aluminum plates and clevises. The initial design height of the column is 10.0 ft with approximately 8.0 feet of active section. However, the current design allows for the column height to be expanded to approximately 28 feet, with 25.0 feet of active section. Glass reservoirs above and below the column allow for phase separation before product discharge. The total volumetric capacity of the completed 10 foot column, including the settling reservoirs, is approximately 5.0 gallons. Within the column’s active section, 2.0 inch diameter stainless steel nozzle plates are positioned 2.0 inches apart on a stainless steel all-thread rod. The single rod is suspended by a stainless steel support plate placed in between two sections of glass pipe above the active section. Glass joints are sealed with Teflon Machined Envelop Gaskets (TMEG) and are joined with cast iron flanges, spring washers and associated hardware.

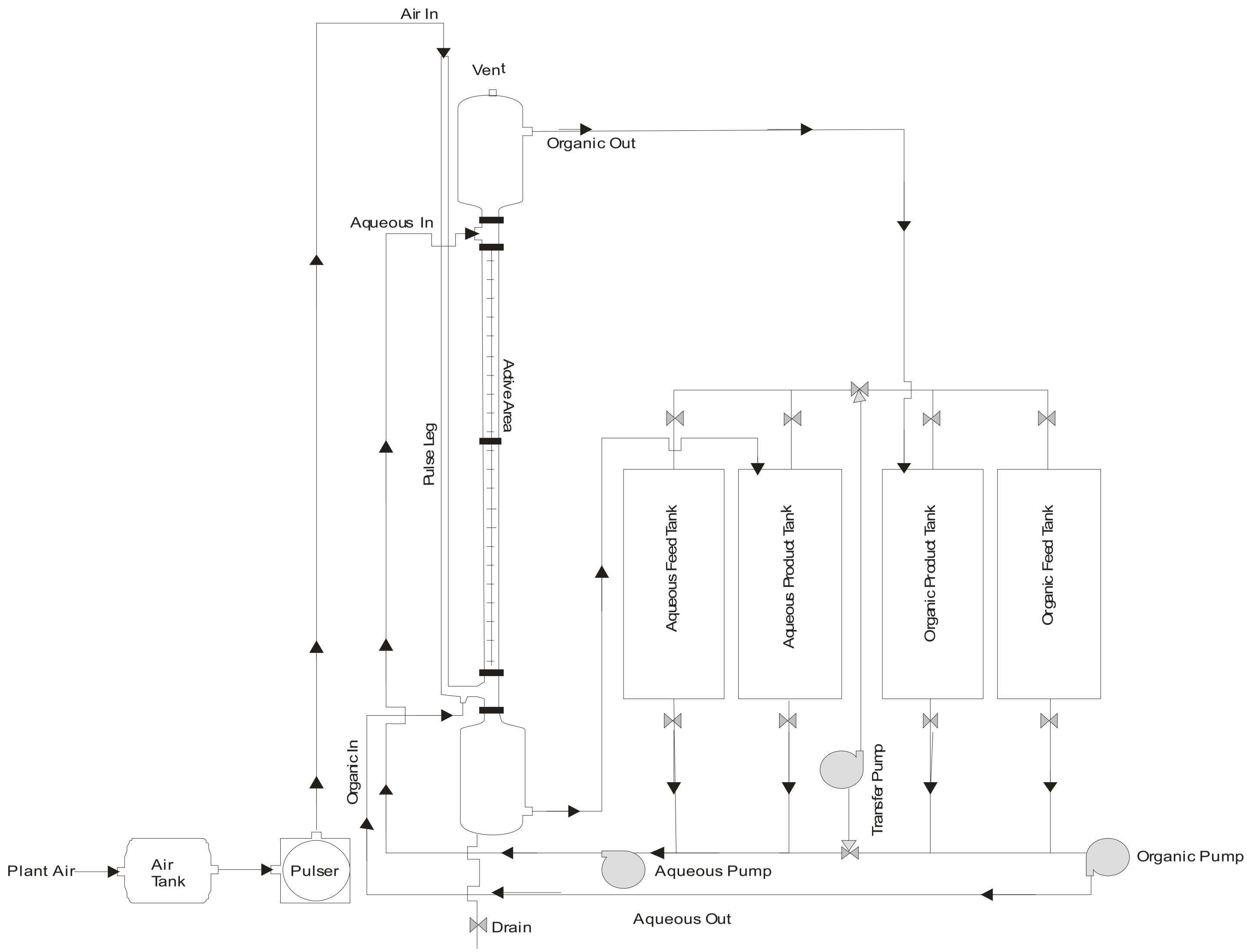

Figure 1. Schematic diagram of the pulse-plate pilot plant. See text for detailed discussion.

A 1.0 inch OD, glass pneumatic pulse-leg, is connected to the column above the bottom settling reservoir. This glass column extends vertically above the top settling reservoir to ensure the column will not drain due to siphoning forces. Glass joints are sealed with TMEG and are joined together with cast iron flanges, spring washers and associated hardware.

Feed and product solutions are contained in four, 28.0 gallon rectangular tanks. The tanks are constructed of High Density Polyethylene (HDPE) and were specifically designed and manufactured for the pilot plant. Two gear pumps manufactured by Micropump® are situated below the tanks to provide solution flow. A third gear pump, situated between the aqueous and organic feed pumps, allows for solution transfer between process tanks or to outside containment. All pumps are of stainless construction and are rated for flowrates of 0.1 to 1.0 gpm. Aqueous and organic flowrates are monitored by turbine style flow meters manufactured by FTI Flow Technology. The column, pumps and tanks are connected by HDPE tubing and associated Swagelok® fittings. The tank side view of the pulse-plate column pilot plant is shown in Figure 2.

Figure 2. Tank side view of the pulse-plate column pilot plant.

A rotary disc pulser, fabricated at the INL, is incorporated into the system to provide a pneumatic pulse to the column. Air supply will be regulated via a standard air regulator to control air pressure to the column (0-50.0 psig). The air from the regulator is fed to an ASME rated metal reservoir to maintain constant pressure. From the reservoir, air is then fed to the inlet side of the pulser and then directed out to the top of the pulse column via PVC pipe. A photo of the rotary disc pulser and metal reservoir are shown in Figure 3. The control panel side view of the pulse-plate column pilot plant is shown in Figure 4.

Figure 3. Rotary disc pulser and pressure reservoir.

Work control documentation (Laboratory Instruction: 136-07-IEDF/IRC) is approved and in-place to support testing of the pulse-plate column pilot plant. However, modifications to this LI are currently underway to continue work at the Bonneville County Technology Center (BCTC). Modifications should be completed by August 2009.

Figure 4. Control panel side view of the pulse-plate column pilot plant.