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HASTELLOY F DISSOLVER INSTALLATION IN 321 BUILDING

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INTRODUCTION

Hastelloy F is a prime contender as a material of construction for plant dissolvers in the power fuel reprocessing program. Consequently, the fabrication and installation of a test dissolver was undertaken to delineate any unknown problems associated with the use of Hastelloy F; and, at the same time, to provide a vessel for development studies on the Niflex or the Sulfex processes. The purpose of this report is to describe the actual basis for design as well as to present the problems encountered during the fabrication of the vessels.

GENERAL DESIGN BASIS

The basic pot and coil concept for dissolvers is not readily adaptable to the processing of nuclear power fuels because of the variation in fuel geometry, and because of criticality considerations. Therefore, a vertical tube dissolver was selected to handle a maximum of 150 pounds of uranium as a power reactor fuel assembly. The layout of equipment is shown in the accompanying schematic diagram. Actual design details are shown on Sk 3-8015. Other pertinent design numbers are listed below:

Hastelloy F Dissolver (A-10) - A 9-inch inside diameter tube 8 feet long, with a 2x2x2-1/2-foot vapor box at the top.

Vertical tube section volume	93 liters
Maximum capacity (tube plus box)	370 liters
Working capacity	250 liters
Heating or cooling surface area	16.9 sq ft
Maximum heat load	125,000 to 150,000 Btu/hour

Condenser (E-10) (Hastelloy F) - A cold 4-inch "finger" surrounded by a jacketed 6-inch tube for updraft or downdraft operation.

Outside shell	6-inch ID
Inside finger	4-1/4-inch OD
Over-all length	10 feet
Inside finger surface	9.52 sq ft
Outside shell surface	13.75 sq ft
Cooling load of both units	200,000 Btu/hr

Scrubber (T-10)(Stainless Steel) - An 8-inch diameter tower, 10 feet long, packed with eight feet of 1-inch stainless steel raschig rings.

Present maximum measurable, off-gas capacity of the dissolver system is approximately 10 scfm.

MATERIALS OF CONSTRUCTION

Hastelloy F was used in all locations, which would be in contact with corrosive solutions. Stainless steel was used for steam jackets, flange rings and other less corrosive parts of the dissolver system. The Hastelloy F components of the dissolver were fabricated from 1/8-inch Hastelloy sheet or Hastelloy rod 3/32- to 5/8-inch in diameter. Teflon tubing connected to the dissolver with a Teflon packing gland was used for all piping of 1-inch diameter or less. Penton valves were used for the sampler posts.

Vacuum melted Hastelloy F, with a carbon content of less than 0.02 percent, was used for all sheet, rod, and welding wire. Chemical analyses of the three heats of metal were as follows:

		Analysis		
	Heat :	FV-152	FV-153	FV-155
Composition	Shape:	Rod	Sheet	Sheet
C		0.02	0.02	0.01
Cr		22.95	21.30	21.88
Ni		44.30	45.70	46.00
Mo		6.51	6.50	6.43
Nb				
Ta		.58	.89	.86
Cb & Ta		2.22	2.28	2.21
Mn		1.82	1.59	1.70
W			.07	.06
Si		.72	.39	.34
P		.014	.005	.001
SSt			.007	.015
Co		.80	.19	.19
Cu			.06	.05
Fe		Bal	Bal	Bal

FABRICATION AND HEAT TREATMENT

On October 7, 1958, fabrication of the dissolver and the condenser was started by 321 Building maintenance forces. Very little information on the fabrication of Hastelloy F was available at that time; however, welding techniques quite similar to those for stainless steel were anticipated. The actual welding proved to be quite different from that of stainless steel. Numerous test welds were required in order to develop a technique for welding Hastelloy F metal with Hastelloy F welding wire. Uneven weld penetration on the test coupons was a major problem. This was apparently caused by variations in one or all of the following: bevel, purge rate, current setting, speed of travel, cleanliness, size of weld rod, and alignment of material. Considerable welding experience was required before the welder could "read" the molten metal puddle and determine the extent of penetration and appearance of the bead on the back side of the weld.

The following methods were used in actual fabrication. The longitudinal seams of the tubing were machine beveled to 37-1/2° angle before rolling. Flat butt welds were beveled to 45° angle with a maximum land of 1/64-inch. In all instances a 1/16-inch gap was used. Welding wire and machined or sheared edges were cleaned with a 20 percent HNO_3 or acetone and water solution before welding.

Good welds were produced only by the use of the proper size welding wire. The available 3/32-inch Hastelloy F welding wire was too large for the butt welds of 1/8-inch plate with a 1/16-inch gap and a 45° bevel; but welding with a 1/16-inch Hastelloy F wire was very satisfactory. (The 3/32-inch wire was extruded to 1/16-inch diameter and degreased.) An argon shielded 3/32-inch 2 percent thoriated tungsten electrode was used in welding. Argon shielding gas flows were 15 CFH on the arc and 20 CFH on the back side purge. Adequate pre-weld purge was indicated by a Fyrite instrument. Welds of two to three stringer beads were made on the 1/8-inch material, but three beads were used most frequently. The heat of the parent metal was kept to a minimum by the following machine settings:

First pass - 85 to 98 amps and 28 to 30 volts
Second pass - 85 to 90 amps and 28 to 30 volts
Third pass - 98 to 104 amps and 30 to 34 volts

Initally, cracks were produced in the longitudinal seams of tubing welds, if the weld was started at the end of the tube. Such cracks were eliminated by starting the weld six inches from the end of the tube and welding towards the end. Later, radiographing or micrographing showed neither cracks nor pinholes in any of the welds made by the experienced welder. Many of the welds were examined by the Metallurgical Laboratory, and their report showed complete penetration, good bonding characteristics, welds free from dirt, slag, or non-metallic inclusions, and no cracks or pinholes. The vendor's representative also inspected our welds and found them to be as good as, and in most cases better than, similar welds made by other Hastelloy F fabricators. However, Radiographic Testing Operation reported some undercut welds and concluded that the welds did not meet specifications for ASME 1956 Boiler and Pressure Vessel Code, Section VIII for unfired pressure vessels.

The dissolver and the condenser were heat treated to anneal the welds and to increase corrosion resistance. All accessible surfaces were washed or swabbed with 10 percent Diversey 514 solution and a 5 percent HNO_3 solution before heat treatment. Heat treatment consisted of placing the vessels in the furnace, heating to 2125 F and maintaining this temperature for one hour; then, quenching with water. Approximately 7 hours of heating was required to reach 2125 F in the 200-East oil fired furnace. After the prescribed one hour of annealing, removal of the vessels and quenching was delayed for a period of 5 minutes by a jammed furnace door. (Immediate quenching is important for maximum corrosion resistance, and the delay in quenching may have decreased the corrosion resistance of the vessels.)

Distortion or warping of the vessels by the heat treatment and water quench was not visible. Oxidation was not severe. Weld cracks were not evident by standard dye techniques.

Following the heat treatment, stainless steel parts -- such as stainless steel jackets -- were welded to external parts of the Hastelloy F vessels with 308-L welding wire.

INSTALLATION:

The dissolver and the condenser were ready for installation on December 9, 1958. Installation was accomplished on schedule with a high degree of cooperation from all of the crafts. Equipment shakedown and final instrument checking required approximately one week. The equipment was ready for operation by January 23, 1959. The actual schedule is shown in the attached table.

COSTS:

Several instruments and other items -- such as recorders, pneumatic transmitters, rotometers, valves, gages, a scrubbing tower, and other miscellaneous stainless steel parts were available from previous development projects, and their cost is not included. Purchased materials are listed in two categories -- special items and Central Stores stock items. Special items included such material as 9 sheets of Hastelloy F (3x8 ft), welding wire, Teflon tubes and special valves. Stores stock items include those items purchased from excess stock -- such as instrument cabinets.

Approximately $19,500 was spent for the over-all dissolver system. Of this, approximately $7,000 was for material, $5,000 for labor during fabrication, and $7,500 for labor during installation.

HASTELLOY F DISSOLVER COST SUMMARY

Materials

Special Items	$5,579
Instruments	1,300
Stores Stock Items	350
	$7,229

Fabrication

Minor Construction	$ 460
Dissolver	2,255
Condenser	1,172
Heat Treatment	800
	$4,687

Installation $7,500

Grand Total --- $19,416

SUMMARY OF ACTUAL SCHEDULE

Dissolver scoped and Hastelloy F requisitioned	May 15, 1958
Hastelloy F order placed	June 6, 1958
Hastelloy F sheet received	September 8, 1958
All Hastelloy received	October 22, 1958
Pipe forming and fabrication started	October 7, 1958
Installation work started	October 31, 1958
Heat treatment completed	December 2, 1958
Fabrication completed	December 17, 1958
Installation completed	January 16, 1959
Dissolver operating (1st run)	January 23, 1959

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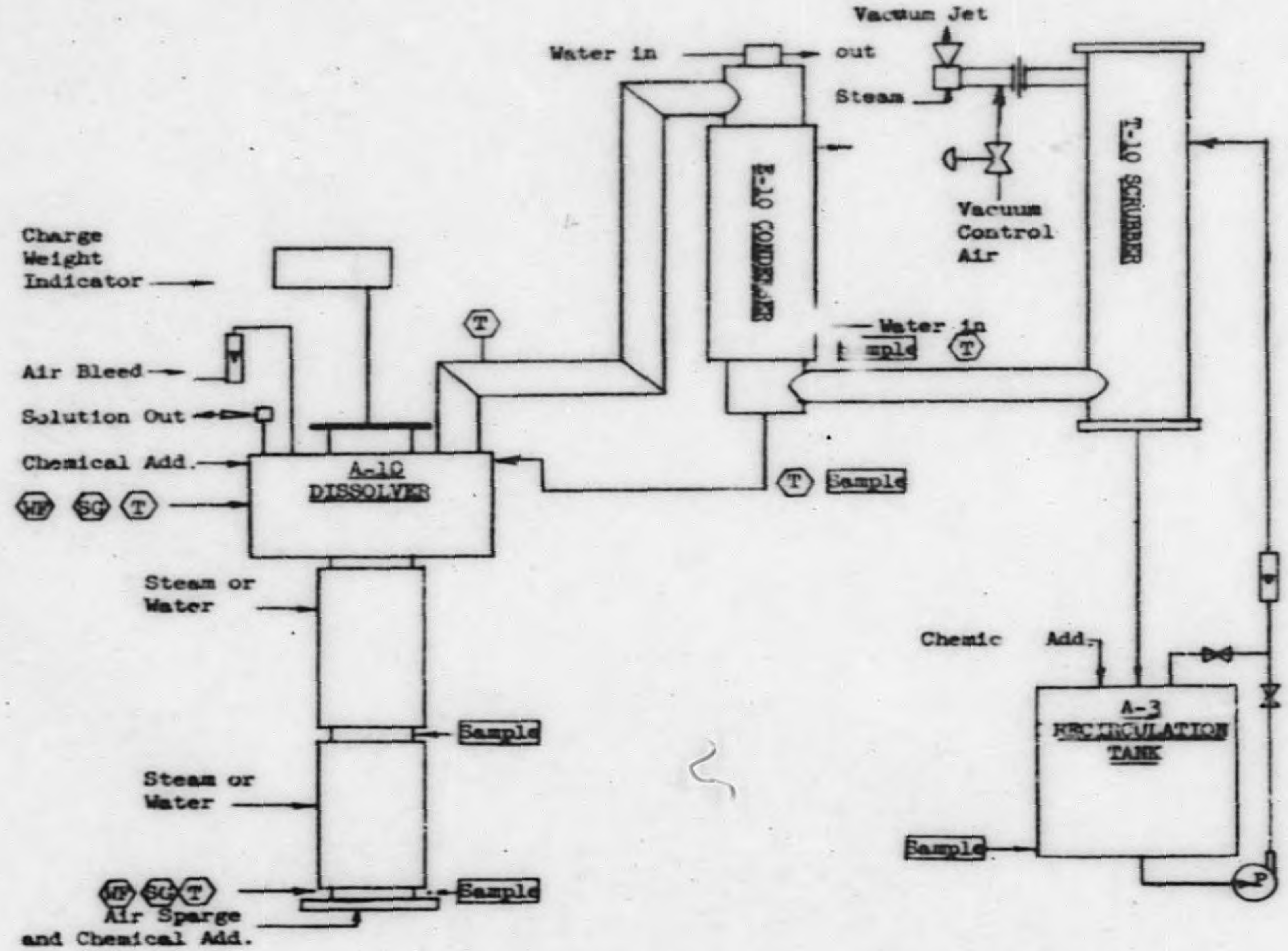

HASTELLOY F EXPERIMENTAL DISSOLVER FACILITY

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