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CLASSIFICATION CANCELLED

DATE 2-20-57

For The Atomic Energy Commission

H. F. Canale

Chief, Declassification Branch

RECOMMENDED PULSE COLUMN DIMENSIONS AND ACCESSORIES FOR THE THOREX PILOT PLANT

By
A. C. Jealous

Photostat Price \$ 1.80

Microfilm Price \$ 1.80

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Oak Ridge, Tennessee

UNITED STATES ATOMIC ENERGY COMMISSION
Technical Information Service, Oak Ridge, Tennessee

AEC RESEARCH AND DEVELOPMENT REPORT

542 1

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Pulse column capacities and lengths have been experimentally determined for the three Thorex Process contactors, and the recommended dimensions for the Thorex Pilot Plant columns are presented in this memo. These dimensions (See Table 1) are scaled directly from the Unit Operations column tests and are intended to accommodate a nominal throughput of 100 kg Th/day (with a maximum up to 150 kg Th/day) and recover greater than 99.9% of the U and Th in each contactor.

The following dimensions are based on results obtained in 2 in. diameter columns and with Th feed solution prepared from digested thorium nitrate tetrahydrate.

TABLE 1

Recommended Diameters & Lengths
for Thorex Pilot Plant Pulse Columns

Basis: (a) Nominal Throughput: 100 kg Th/day (@ 61% of flooding in A column; maximum throughput 150 ~~kg~~ kg Th/day @ 90% of flooding in A column)

(b) U and Th Losses: less than 0.1% per stream

Column	Type	Diameter (in.)	Section	Length (ft)
A	Vertical	3	Extraction Scrub	8 20
B	Concatenated	4	Org. Scrub Strip Water Scrub	15 20 10
C	Concatenated	4	Strip	36

Column Diameters

The A column diameter should be 3 in. and the diameter for the B & C columns should be 4 in. to accommodate a nominal throughput of 100 kg Th/day (maximum up to 150 kg Th/day). The 3 in. diameter for A column will result in operating this column at about 61% of flooding, when the pulse conditions are 0.7 in. amplitude and 40 ± 5 cycles/min frequency. The 4 in. diameter B & C columns will operate at about 45% & 38% of the flooding point, respectively, when using pulse conditions of 1.0 in. amplitude and 50 ± 5 cycles/min frequency.

The 3 in. A column diameter was based on use of clear Th feed solution from digested TNT. Use of the feed digestion procedure proposed by the Chemical Development Section to clarify the dissolver solution indicates that A column operation in the Pilot Plant can be satisfactorily carried out at rates defined in the UNOP tests in which the feed solution was prepared from digested TNT.

5422

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The C column volume throughput has been reduced by the change in flow ratio to 1:5 (aqueous:organic) such that 100 kg Th/day operation now means operation at 38% of flooding in a 4 in. diameter C column.

A small adjustment of the pulsing conditions, particularly such as increasing the frequency over the values mentioned above, will effectively redefine the flooding point for the same flow rate (i.e., a lower flooding point results from a higher frequency for the same flow rates) and thus result in the operation of the columns at a higher percent of flooding.

Column Lengths

The A column should include at least eight feet of extraction section and 20 ft of scrub section. Eight feet of extraction will result in $\leq 0.1\%$ Th and U loss. The Chemical Development Section has indicated that approximately eight to ten stages are required for adequate decontamination of the Th and U^{233} ; hence, assuming a stage length of 2 ft for the scrub section, 20 ft will accommodate ten stages. It is recommended that two alternate feed and solvent entrance points be provided in the A column with appropriate valving at 2 ft intervals above both the bottom and 8 ft feed points. These alternates should permit closer definition of the scrub height requirements during the Pilot Plant program.

The concatenated B column should provide at least 15 ft of organic scrub, 20 ft of acid strip, and 10 ft of water scrub. These lengths should provide ≤ 0.1 U loss, approximately 5×10^4 separation of Th from U, and an acid concentration in the U^{233} organic stream to the C column of less than $0.02N$ HNO_3 .

The concatenated C column should consist of 36 ft of column length in order to provide less than 0.1% U loss.

Column End Geometry

The bottom end of the A column should be designed to accommodate operation with the interface at the bottom of the column and to provide 20 to 30 min holdup for adequate disengaging of the solvent and aqueous phases. The top end of the A column should also accommodate operation with the interface at the top and should also provide 30 min holdup for adequate phase disengagement. (Basis: 100 kg Th/day).

The end sections for the B and C column should provide 30 min holdup for phase disengagement but need only accommodate interface control probes in the top end section of each of these columns. The top ends of the intermediate sections in the concatenated columns need only be large enough to accommodate the transfer tube inlet and outlet nozzles with the outlet being at the uppermost point. Suggested dimensions for the 4 in. diameter concatenated columns are 6 in. diameter by 10 in. long. The aqueous inlet should enter tangentially.

Phase disengagement is required in the bottom end pieces of the intermediate sections to prevent building up emulsions from the inlet stream, which would recirculate and eventually reduce the contactor capacity. Hence, it is recommended that the dimensions of the bottom end pieces be 8 in. diameter by 1 ft length. The inlet

5423

(organic) stream should tangentially enter the upper part of the bottom piece and the exit (aqueous) stream should be located at the lowest point of the end piece.

Check Valves and Transfer Tubes

The transfer tubes for the 4 in. concatenated pulse columns should be approximately 0.5 in. diameter connecting to approximately 1.0-1.5 in. diameter tangential entrance nozzles on the end pieces on the intermediate sections of the concatenated column. Enlarged exits from the end pieces are not necessary. Disc-type check valves (See Dwg. #D-14317) should be used for the transfer tubes in the concatenated columns and should be dimensioned as in Dwg. D-14317.

Instrumentation

It is recommended that probes and other connections be provided to accommodate the various interface and pulse indicator-controller instruments which are under development and which have been tested on the Unit Operations columns. These instruments include:

- (1) The pneumatic transmitter system for interface indication and control.
- (2) The pneumatic transmitter system for pulse amplitude indication.
- (3) The strain gauge type transducer system for recording the pulse wave trace on a Sanborn oscillograph or simply indication on an oscilloscope.
- (4) The capacitance system for interface recording and controlling.

All of these are described in a memo (ORNL, CF #53-6-105) by T. M. Gayle, the Instrument engineer who has been developing these units.*

Briefly, the first system above is a Taylor instrument incorporating a more sensitive transmitter requiring a smaller air purge. The Taylor transmitter provides full scale action for only 2.9 in. of water differential vs. 20 in. for the Minneapolis-Honeywell transmitter. The second system, for pulse amplitude indication, is similar to the Taylor interface control instrumentation with the addition of a check valve system to permit indicating the span or amplitude of the interface movement. The transducer system (third, above) incorporates an electronic strain gauge unit which signals to either the oscillograph or oscilloscope, showing the variation in liquid head acting on the transducer and resulting from the pulse action. The capacitance instrumentation consists of a ceramically encased probe which senses variations in the electrical capacitance of the liquid-liquid system in which it is immersed. The variation in capacitance sensed by the probe results from variation of the relative degree of immersion of the probe in each of the two phases at the interface. Each of these systems has been tested on the experimental columns in Unit Operations. Ultimately, if the capacitance system proves reliable and accurate it should be selected for the production plant. Meanwhile, accommodation of the four systems in the Pilot Plant will provide firm experimental demonstration of the validity and usefulness of each system, thus permitting a reliable comparison and selection of the best system for plant application.

*Copies of T. M. Gayle's memo will be issued to all on the distribution for this memo. 542-4

5

MATERIALS LIST					
ITEM NO.	DWG. NO.	QTY.	NAME	SIZE	MATERIAL
1	This Draw.	1	Valve Body	1 1/8" Dia. X 1 1/2" Lg.	347 S5T
2	This Draw.	1	Guide	1 1/8" Dia. X 1/2" Thk.	347 S5T
3	This Draw.	1	Check Disc	1.095 Dia. X 1/2" Thk.	347 S5T
4	This Draw.	1	Seat	1 1/8" Dia. X 1 1/2" Lg.	347 S5T

1 VALVE BODY
Mat'l: 347 S5T
1-Req'd

2 GUIDE
Mat'l: 347 S5T
1-Req'd

3 CHECK DISC
Mat'l: 347 S5T
1-Req'd

4 SEAT
Mat'l: 347 S5T
1-Req'd

NOTES:

After Spot Welding Guide, Item 2, To Valve Body, Item 1, Insert Check Disc, Item 3, & Weld Item 1 To Seat Item 4.

Welded Const: Welds May Be Inert Gas Shielded Arc, Or Metallic Arc. Filler Mat'l Must Be The Type S5T As Parent Metal.

MACHINE FINISH SPECIFICATIONS:

1. Finish symbols are in accordance with ASA Standard B46.1 - 1947.
2. Roughness height values are the maximum arithmetical average deviation from the mean surface, expressed in microinches.
3. For surfaces not otherwise indicated, roughness height shall not exceed 32.

THIS DRAWING IS CLASSIFIED **SECRET**
 AUTHORITY **SECURITY**
 BY **W.C. [Signature]**
 DATE **10/1/50**

LIMITS ON DIMENSIONS UNLESS OTHERWISE SPECIFIED
 FRACTIONS: $\pm .005$
 DECIMALS: $\pm .005$
 ANGLES: $\pm 0^{\circ} 30'$
 SCALE: 1" = 1"

REFERENCE DRAWINGS DWG. NO.

Thorex Hopper Skg Conveyor Bldg. #3502
 ASSEMBLY & DETAILS OF
 CLARK DISC CHECK VALVE TYPE 2
 OAK RIDGE NATIONAL LABORATORY
 OPERATED BY
 CARBIDE AND CARBON CHEMICALS COMPANY
 A DIVISION OF UNION CARBIDE AND CARBON CORPORATION
 OAK RIDGE, TENNESSEE

SUBMITTED **10/1/50** APPROVED **[Signature]**
 NO. 478249 D-14317

NO.	REVISIONS	DATE	APPR.	APPR.
DRAWING NO. D-14317				
DESIGNED	DATE	CHECKED	DATE	APPROVED
W.C. [Signature]	10/1/50			
DRAWN	DATE	SUBMITTED	DATE	APPROVED
P. [Signature]	10/1/50			
ENGINEER	DATE	OPERATIONS	DATE	SAFETY
FILE PROTECTION	RESEARCH GROUP	MAINTENANCE		

548-5

According to T. M. Gayle, a 15 in. probe separation should be provided for the pneumatic systems, and the capacitance probe should extend down from the top to the same level as the lower pneumatic probe. It is recommended that a 1 ft vertical section with a cross-sectional area about twice that of the column should be provided just above the column plates (this means that the upper pneumatic probe would be a few inches above this section, and thus in the enlarged deentrainment section). The interface is to be kept within this vertical section. Provision of this section will facilitate instrument sensing of the interface movement due to pulse action. This movement would be dampened too greatly if maintained in the larger deentrainment section.

The transducer should be attached to a 1/8 in. IPS pipe connection just below the top perforated plate. A 1.5 in. pipe thread should be provided in the column top flange for inserting the capacitance probe.

ACJ:mh

A. C. Jealous
A. C. Jealous

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