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PUREX PLANT SMALL PULSE GENERATOR OPERATION

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PUREX PLANT SMALL PULSE GENERATOR OPERATIONINTRODUCTION

Flowsheet considerations and information developed for the large (size 2) Purex pulse generator⁽¹⁾ indicated the need for information on the operating characteristics of the small (size 1) Purex pulse generator. To develop this information, the spare small Purex pulse generator was installed and operated on the prototype Purex 2A Column.

SUMMARY

The leakage rate past the piston of a small (size 1) Purex pulse generator is not affected significantly by pulse frequency. With the piston weep hole plugged, about 0.05 gal./min. leaks by the piston. With a 3/64-in.-diameter weep hole, the leakage rate does not exceed 0.20 and 0.22 gal./min. for organic (30 vol. % TBP in hydrocarbon diluent) and water, respectively.

Not more than one standard cubic foot per minute of air is required to maintain a static balance (no liquid leakage past the piston) between the pulse leg and the pulse column. All air in the pulse leg is vented to the column in less than three minutes.

DISCUSSION

The spare small Purex pulse generator (PG-J4-OS) was operated on the prototype Purex 2A Column pulsing both water and Purex organic. This installation was identical to the Purex Plant 2A Column installation. Tests were conducted to (1) determine leakage rate past the piston; (2) determine the air pressure and flow required to hold the column in equilibrium during short shutdowns, when air is applied under the piston; (3) determine the time required to bleed all air from the pulse leg when filling the column; (4) determine the maximum and minimum liquid pressures at the piston face; and (5) evaluate the mechanical operability of the unit.

Liquid Leakage Rates Past the Piston - The 7.5-in.-diameter piston in this unit has four rows of expanding rings and two guide rings. Originally, all units had a 3/32-in.-diameter weep hole for venting and/or draining; however, the weep hole on one unit was plugged and the other weep holes were reduced to 3/64-in. diameter before the pulsers were installed.

The pulse generator was operated pulsing water or organic at various frequencies while leakage data were taken. The test unit weep hole plugged with foreign material from the pulse leg two times when pulsing was first started. Extensive back flushing was required to remove the plug, and the leakage data taken in each case agreed; therefore, it was concluded that the data obtained while the hole was plugged are typical for a piston without a weep hole. The column

(1) "Purex Pulse Generator Operation" by P. B. McCarthy, HW-36836, May 11, 1955.

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and pulse leg were flushed extensively before leakage rate data were taken for a 3/64-in. diameter weep hole.

The leakage rate did not exceed 0.25 gal./min. when the piston was operated at frequencies below 80 cycles/min. and the 3/64-in.-diameter weep hole was open. The leakage rate decreased to about 0.2 gal./min. when the frequency was increased to 100 cycles/min. Similarly, when organic was pulsed, the leakage rate did not exceed 0.022 gal./min. at frequencies less than 80 cycles/min., decreasing to about 0.15 gal./min. at 100 cycles/min. With the weep hole plugged and water in the column, the leakage rate was about 0.05 gal./min. at all frequencies tested. The data from these tests are presented in Table I.

Air Requirements to Prevent Leakage During Shutdown - Air can be introduced below the piston of the Purex Plant pulse generators to prevent liquid leakage past the piston in the event of a crash shutdown. The quantity of air required to maintain a constant liquid level in the pulse leg is dependent on the pulse column and pulse leg liquid levels (pressure). Air flow rates ranged from 0.6 to 1.0 std. cu. ft./min. at pressures ranging from 10.0 to 17.2 lbs./sq. in. ga. when a 3/64-in.-diameter weep hole exists. With the weep hole plugged, the flow was less than 0.5 std. cu. ft./min. (lower limit of metering equipment) at the maximum pressure (17.2 psig). The data from these tests are given in Table II.

Pulse Leg Vent Time - To obtain lubrication of the piston rings and uniform pulsing, it is necessary to bleed all air from the pulse leg before pulsing is started. Under the worst conditions (weep hole plugged) the pulse leg was completely vented three minutes after the column was filled. Normally, three minutes were required to fill the column. With a piston weep hole, the pulse leg was completely vented when column filling was completed.

Piston Face Pressures and Power Input - A strain-gage type pressure transducer coupled with a recording Sanborn instrument was used to determine the pressure fluctuation at the piston face when the column was full of water. As the frequency of pulsation increases the maximum pressure increases and the minimum pressure decreases as shown in Figures 1 and 2. Also, as frequency increases, the input power requirement increases to 1.11 horsepower at 100 cycles/min. The pressure and power data are given in Table III.

Mechanical Operability - The pulse generator operated trouble-free for a total of 682 hours. The unit was inspected after operation was terminated--the oil reservoir was free of moisture, and no sign of excessive wear could be detected. Leakage data taken after 682 hours operation were identical with those obtained when the unit was new.

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TABLE I

PUREX PLANT SMALL PULSE GENERATOR TESTSLiquid Leakage Rates Past Piston

Size 1 Purex Pulse Generator, PG-J4-OS, on 321 Building Prototype 2A Column
Head Against Piston 24.7 Ft.

Weep Hole Diameter, Inch	Solution in Column	Frequency Cycles/Min.	Leakage, Gal./Min.		Comments
			At 1 Hour	After 682 Test Hours	
0(1)	Water	0	0.045	----	(1) Weep hole accidentally plugged by solids in pulse leg.
		27	0.049	----	
		64	0.045	----	
		81	0.050	----	
		100	0.045	----	
3/64	Water	0	0.247	0.238	
		44	0.254	0.246	
		70	0.248	0.236	
		99	0.185	0.182	
3/64	Organic (2)	0	0.206	0.209	(2) 30 Vol. % TBP in Shell Deodorized Spray Base.
		37	0.209	0.212	
		58	0.203	0.203	
		79	0.185	0.186	
		99	0.156	0.140	

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TABLE IIPUREX PLANT SMALL PULSE GENERATORAir Under Piston Used to Balance Column Head and Prevent Piston Leakage

Size 1 Pulse Generator, PG-J4-OS, on 321 Building Prototype 2A Column
Head against Piston 24.7 Ft.
Pulse Frequency - 0 Cycles/Min.

<u>Weep Hole Diameter, Inch</u>	<u>Solution in Column</u>	<u>Pressure Under⁽³⁾ Piston, Lb./Sq. In. Gage</u>	<u>Air Flow Rate⁽²⁾ Std. Cu. Ft./Min.</u>
0	Water	17.2	<0.5 ⁽¹⁾
3/64	Water	17.2	1.0
3/64	Water	14.0	0.9
3/64	Water	11.2	0.8
3/64	Organic	14.8	1.0
3/64	Organic	12.1	0.9
3/64	Organic	10.0	0.6

(1) Below range of metering device.

(2) Air supply located below piston.

(3) Determined by liquid level in pulse leg if column is full.

TABLE IIIPUREX PLANT SMALL PULSE GENERATOR TESTSPower Requirements and Pressure Under Piston

Size 1 Pulse Generator, PG-J4-OS, on 321 Building Prototype 2A Column⁽¹⁾
Head Against Piston: 24.7 Ft.
Pulse Leg Length: 29.0 Ft.
Pulsed Solution: Water

<u>Frequency</u> <u>Cycles/Min.</u>	<u>Amps</u>	<u>Volts</u>	<u>Input H.P.</u>	<u>Pressure Under Piston⁽²⁾,</u> <u>Lb./Sq. In. Ga.</u>	
				<u>Maximum</u>	<u>Minimum</u>
0				+ 10.7	+ 10.7
27	.20	103	0.04	+ 11.2	+ 9.2
47	.37	183	0.16	+ 13.8	+ 6.6
70	.75	275	0.48	+ 17.1	+ 3.5
100	1.20	400	1.11	+ 22.2	- 1.2

(1) Packed Column.

(2) Determined by using pressure transducers.

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PISTON PRESSURE - LBS/SQ IN ABS

FIG 1

PULSE PRESSURE VS FREQUENCY

PRESSURES UNDER SMALL (SIZE 1) PUREX PULSE GENERATOR
PISTON, PULSING WATER IN PACKED 2A PROTOTYPE COLUMN

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FIGURE 2

PUREX PLANT SMALL TOLUENE TESTS

Pressure Fluctuation Curves Taken at Piston Face

Size 1 Purex Generator, PG-J4-OS,
On 321 Building Prototype 2A Column
Head against Piston 24.7 Ft. (10.6 Lbs./Sq. In. Ga.)

Min. 22.1 Lb./Sq. In. abs.

Max. 27.1 Lb./Sq. In. abs.

38 Cycles/Min.

Min. 19.0 Lb./Sq. In. abs.

Max. 31.0 Lb./Sq. In. abs.

63 Cycles/Min.

Min. 15.8 Lb./Sq. In. abs.

Max. 33.9 Lb./Sq. In. abs.

83 Cycles/Min.

Min. 13.6 Lb./Sq. In. abs.

Max. 36.8 Lb./Sq. In. abs.

Note: One MM on vertical
scale equals 0.945 lbs./sq.
in. One second on horizontal
scale equals either 25 or
2.5 in.

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