

FRACTIONATION RESEARCH, INC.

**REPORT OF TESTS
OF
RASCHIG -SUPER RING NO. 2TM RANDOM PACKING**

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REPORT OF TESTS OF RASCHIG SUPER-RINGNO. 2™

(Released to Raschig to do with as they see fit)

SUMMARY

Raschig-Super Ring™ No. 2, a random packing designed and manufactured by Raschig GMBH, has been tested in the F.R.I. 4 foot (1.22 m) diameter high pressure distillation column with a 12 foot (3.66 m) bed depth. The test was conducted with the cyclohexane/n-heptane system at 24 psia (1.65 bar) and the iso-butane/n-butane system at 165 psia (11.4 bar) and 100 psia (6.9 bar). The installation and portions of the tests were observed and approved by Raschig GMBH representatives.

DESCRIPTION OF EQUIPMENT

Packing Raschig-Super Ring™ No. 2 is a wavy shaped propriety random packing. Raschig reports that the packing has a specific area of $29.8 \text{ ft}^2/\text{ft}^3$ ($98 \text{ m}^2/\text{m}^3$) and a void fraction of 0.98. A photograph of the packing is shown in **Figure 1**.

Vapor Distributor The vapor distributor/liquid collector used in the tests, which is shown in **Figure 2**, was designed by Raschig GMBH and manufactured locally in Stillwater, Oklahoma. It consists of three high rectangular risers. Each riser is fitted with an angled cap each consisting of two-sloped perimeter walls. The vapor distributor/liquid collector is fitted with two 13 percent straight segmental downcomers.

Liquid Distributor The F.R.I. tubed drip pan (TDP) liquid distributor, shown in **Figure 3**, was used for all tests. The distributor was fitted with 6.5 mm ID drip tubes for C_6/C_7 tests and 10 mm ID for iC_4/nC_4 tests. A triangular spray header fitted with nine spray nozzles was used as the pre-distributor. 1 inch (25.4 mm) and 2 inch (50.8 mm) full-jet nozzles were used for C_6/C_7 and iC_4/nC_4 tests respectively. A picture of the pre-distributor with 2 inch (50.8 mm) nozzles is shown in **Figure 4**. Prior to installing the TDP in the column, it was water tested on the ground. The water test results, the ratios of standard deviation to mean, are shown in **Figures 5-6**.

Support Plate The packing support plate for the tests was the Norton gas injection plate. A photograph of the support plate is shown in **Figure 7**.

Samplers In-bed and below bed samplers used in this test are F.R.I. center-draw cross samplers as shown in **Figure 8**. The four arms are sloped with 1 inch (25.4 mm) fall toward the center of the sampler. Tubing attached to the bottom of the sampler center is used to withdraw liquid and direct it to a column point on the side of the column.

Gamma Ray Scanning Equipment The gamma ray scanning was performed using a 2 curie Cesium source and a scintillation detector.

INSTALLATION OF EQUIPMENT

Figure 9 shows the column configuration, locating the vapor distributor/liquid collector tray, support plate, samplers, packed bed, thermowells, pressure taps, liquid distributor, and other equipment. A vapor distributor/liquid collector was used to provide a uniform flow distribution of the reboiler vapor prior to entering the bottom of the packing, and to collect the liquid descending from the support plate.

The collected liquid flowed to the bottom of the column by means of two 53 inch (1326 mm) long downcomers. The vapor distributor/liquid collector was installed 33 inches (838 mm) above the centerline of the reboiler vapor return line. A sample cup was placed in the downcomer to capture a liquid sample leaving the tray. The sample cup was attached to the downcomer wall directly, and the top of the cup was flushed with tray deck. Another sample cup was installed near the middle of the tray deck of the vapor distributor/liquid collector. The packing support plate was installed 49 inch (1245 mm) above the vapor distributor. Two cross samplers were installed below the packing support plate. The samplers were 8 inch (203 mm) and 12 inch (305 mm) below the support plate respectively. One sampler was in line with the ridges of the support plate and the other at a 45° angle to it. Two center draw cross samplers were installed in the packed bed. One was at the mid-point of the bed, 72 inch (1829 mm), and the other 13.25 inch (337 mm) above the bottom of the support plate. The mid-point sampler was installed to obtain the composition for the average physical property computation and the bottom sampler to act as a check on the below bed samplers. Thermowells were installed every two feet (600 mm) while the bed was packed. The packing was dry packed to a bed depth of 12 foot (3.66 m). Care was taken to pack the bed without any voids beneath the samplers and the thermowells. The hold down device was a high open area steel cloth placed on the top of the bed and held in place by two rods tack welded to the column wall. The F.R.I. TDP distributor was installed 6 inch (152 mm) above the top of the packed bed. The TDP was suspended with three adjustable rods secured to brackets, carefully centered and leveled with water. The liquid composition of distributor was obtained with a brass tapping inserted in the pan floor and 3/8 inch (9.5 mm) copper withdrawal tubing. The distributor liquid temperature was measured using a thermowell located near the bottom of the TDP.

Packing pressure drop was measured with three pressure transducers: one for the bottom half bed 0-77 inch (0-1.96 m), a second for the top half bed 71-144 inch (1.80-3.66 m), and a third for the overall bed 0-144 inch (0-3.6 m). All distances are measured from the bottom of the support plate. Pressure drops were also measured across the vapor distributor/liquid collector and the liquid distributor. A bubbler connected to a pressure transducer was installed in the liquid distributor to measure the liquid level. Each pressure transducer had its own independent leg and column connection. The legs were continuously purged with a constant flow of nitrogen. Installation of the equipment was witnessed and approved by a representative of Raschig GMBH. After finishing the tests, the packing and other equipment were unloaded and inspected. The packing did not appear damaged and no irregularities were found for all the equipment.

Gamma Ray Two different bed elevations were scanned: 48 and 60 inches (1219 and 1524 mm) from the bottom of the support plate. Each run which was scanned was measured at centerline and 12 inches (305 mm) off centerline.

EXPERIMENTAL PROCEDURE

A process flow diagram of the F.R.I. high pressure distillation unit as configured for these tests is presented in **Figure 10**. The tests were performed with C₆/C₇ at 24 psia (1.65 bar), followed by iC₄/nC₄ at 165 and 100 psia (11.4 and 6.89 bar).

Standard F.R.I. operating procedure is to establish the flood point, decrease operating loads to about 20 per cent of flood to unload the bed, and then run a total reflux efficiency series. A procedure similar to this was followed for most of the data taken. All runs were conducted at total reflux conditions. At the request of Raschig GMBH, no additional pressure drop data was taken at constant liquid loads and various vapor rates.

RESULTS

Results of the Raschig-Super Ring™ No. 2 are presented in Tables I to III. The compositions of the iC₄/nC₄ runs are shown in Tables IV-V. The process density and holdup measured by gamma ray scanning are given in Tables VI-VII. A summary of the run conditions is listed as follows:

<u>Run No.</u>	<u>System</u>	<u>Pressure psia (bar)</u>	<u>Table No.</u>	<u>Run Type</u>
19208-19229	C ₆ /C ₇	24 (1.65)	I	Total Reflux
19230-19249, 19266-19267	iC ₄ /nC ₄	165 (11.4)	II	Total Reflux
19250-19265	iC ₄ /nC ₄	100 (6.89)	III	Total Reflux

NOMENCLATURE

C ₃	Propane
C ₆	Cyclohexane
C ₇	Normal heptane
C _s	Capacity factor, $u_s(\rho_v/(\rho_L-\rho_v))^{0.5}$, ft/s (m/s)
F _s	Superficial F Factor, $u_s(\rho_v)^{0.5}$, ft/s(lb/ft ³) ^{0.5} (m/s(kg/m ³) ^{0.5})
HETP	Height equivalent to a theoretical stage, inches (m)
iC ₄	Iso-butane
nC ₄	Normal butane
u _s	Superficial vapor velocity based on column cross section area 12.56 ft ² (1.17 m ²), ft/s (m/s)
ρ _L	Liquid density, lb/ft ³ (kg/m ³)
ρ _v	Vapor density, lb/ft ³ (kg/m ³)

ABBREVIATIONS

DC	Downcomer sample
Dist	Distributor
Elev	Elevation
FT	Total reflux flood runs
Liq	Liquid
NTD	Notched trough liquid distributor
TDP	F.R.I. tubed drip pan liquid distributor
TR	Total reflux efficiency runs
Vap	Vapor

CONVERSION FACTORS

Parameter	English Units	x	Multiplying Factor	=	S.I. Units
Area	ft ²		0.0929		m ²
Capacity Factor C _s	ft/s		0.3048		m/s
Density	lb/ft ³		16.019		kg/m ³
Duties	M Btu/h		0.2929		MW
Length	ft		0.3048		m
Height	inch		25.4		mm
Liquid flow rate	gpm		0.2271		m ³ /h
Liquid flux	gpm/ft ²		2.4448		m ³ /h-m ²
Mass flow rate	k lb/h		0.126		kg/s
Pressure	psia		0.06895		bar
Pressure drop	inch H ₂ O/ft		8.167		mbar/m
Superficial F-factor Fs	ft/s(lb/ft ³) ^{0.5}		1.22		m/s(kg/m ³) ^{0.5}
Temperature	°F		(°F-32)/1.8		°C

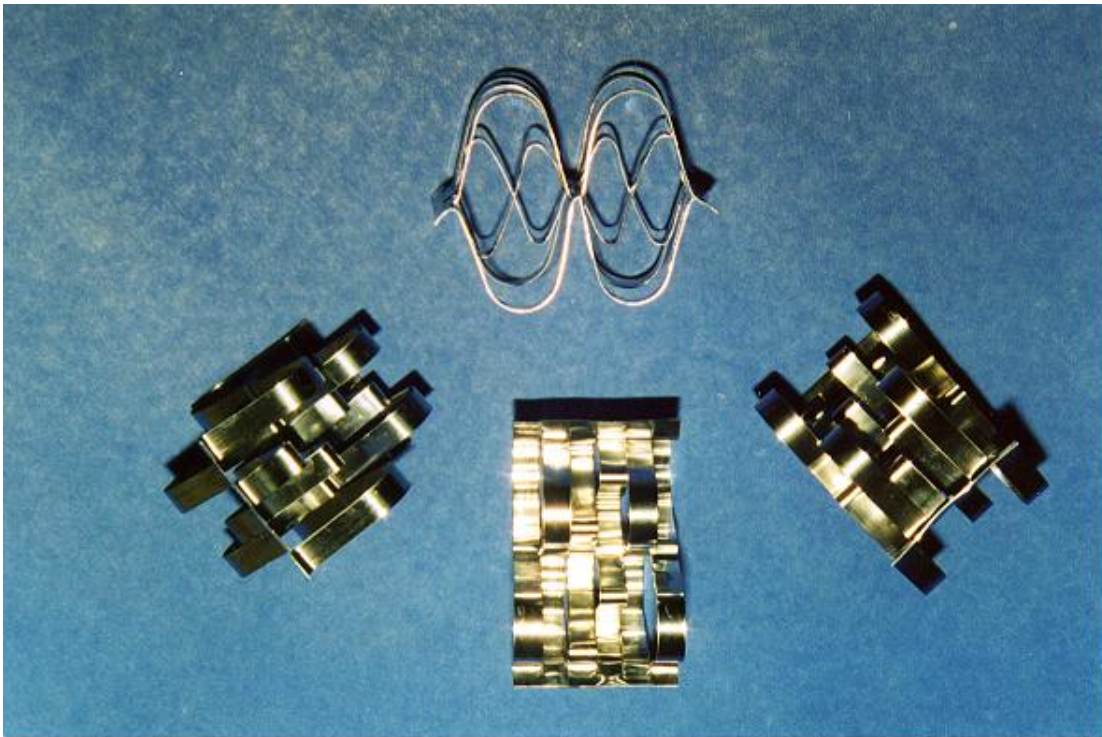


Figure 1. Raschig-Super Ring™ No. 2 Packing



Figure 2. Raschig Vapor Distributor/Liquid collector



Figure 3. F.R.I. Tubed Drip Pan Distributor

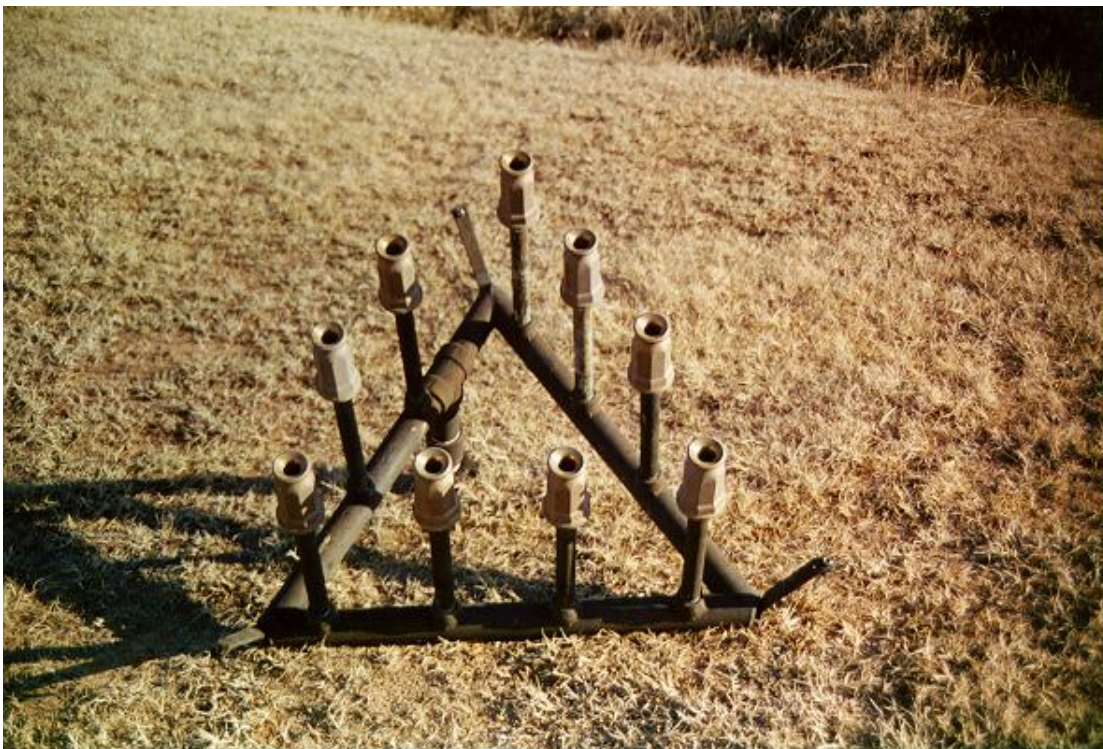


Figure 4. F.R.I. Pre-distributor with 2 inch (50.8 mm) Spray Nozzle

Figure 5. Water Test of F.R.I. TDP Liquid Distributor

Used for C₆/C₇ 24 psia (1.65 bar) Operation
 6.5 mm drip tubes, 9 spray nozzle pre-distributor

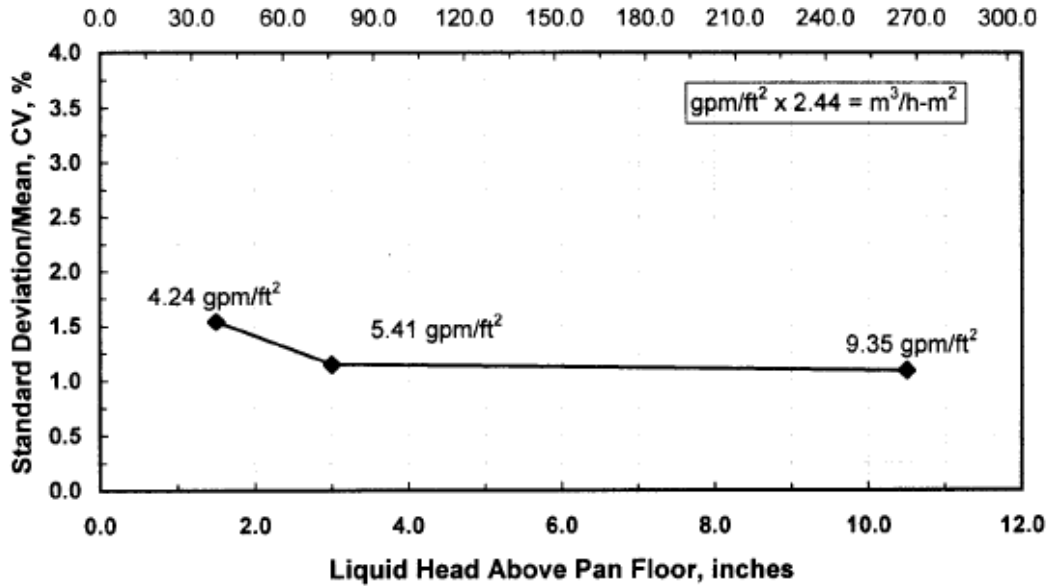
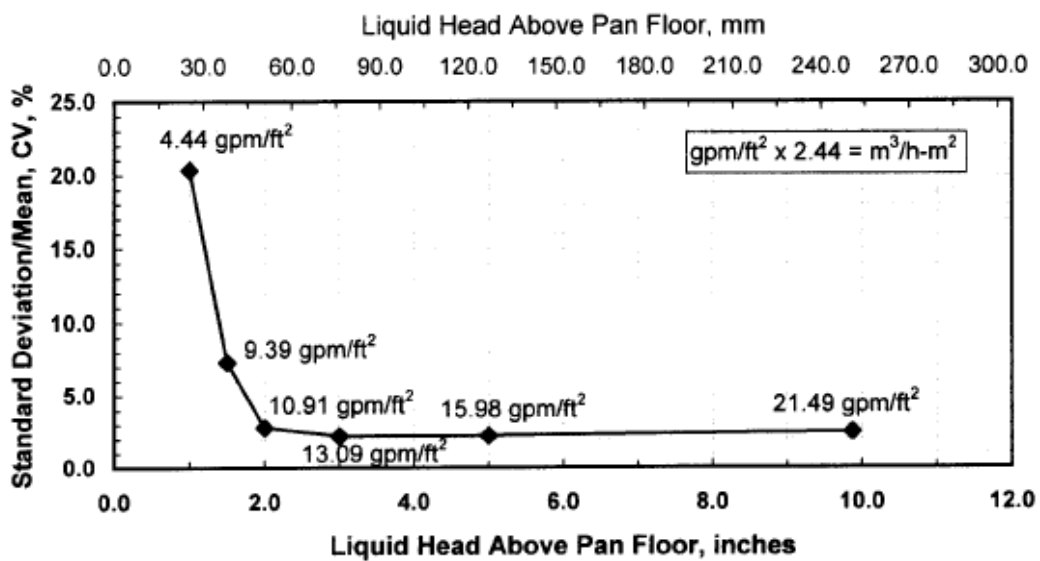


Figure 6. Water Test of F.R.I. TDP Liquid Distributor

Used for IC₄/nC₄ 100, 165 psia (6.89, 11.4 bar) Operation
 10 mm drip tubes, 9 spray nozzle pre-distributor



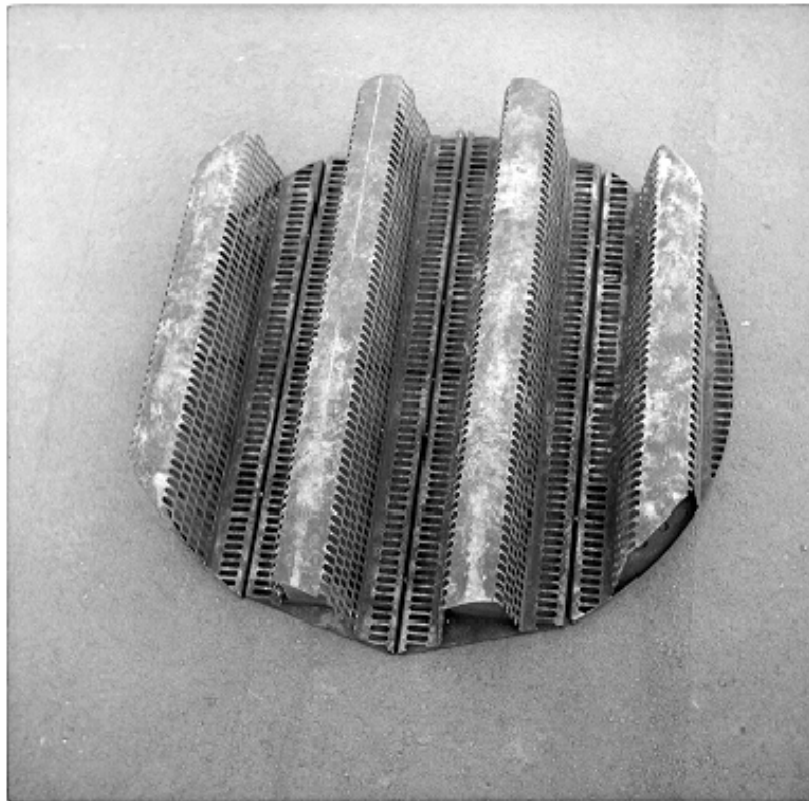


Figure 7 Norton Gas Injection Packing Support Plate

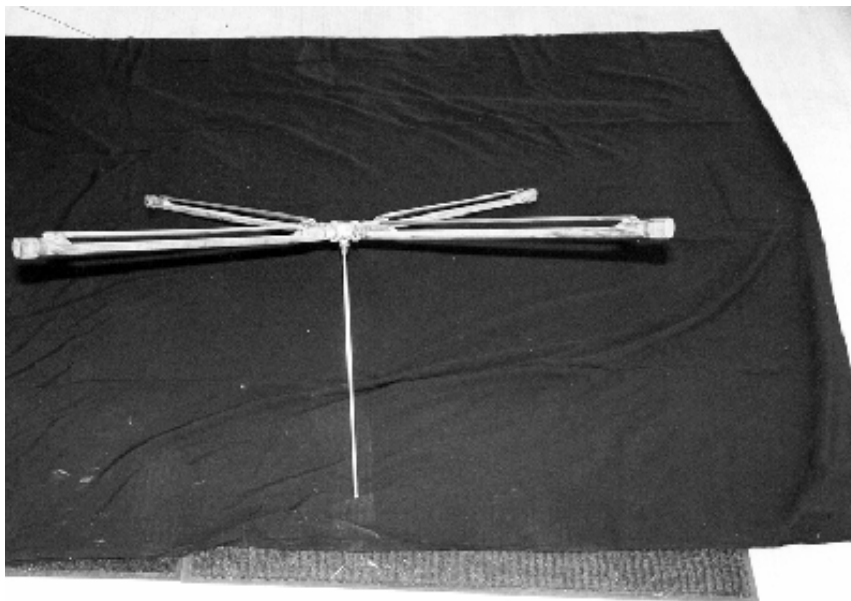


Figure 8. Liquid Cross Sampler

Figure 9. F.R.I. High pressure Column Configuration
 12 Foot (3.66 m) Bed Depth of Raschig-Super Ring™ No. 2 Packing

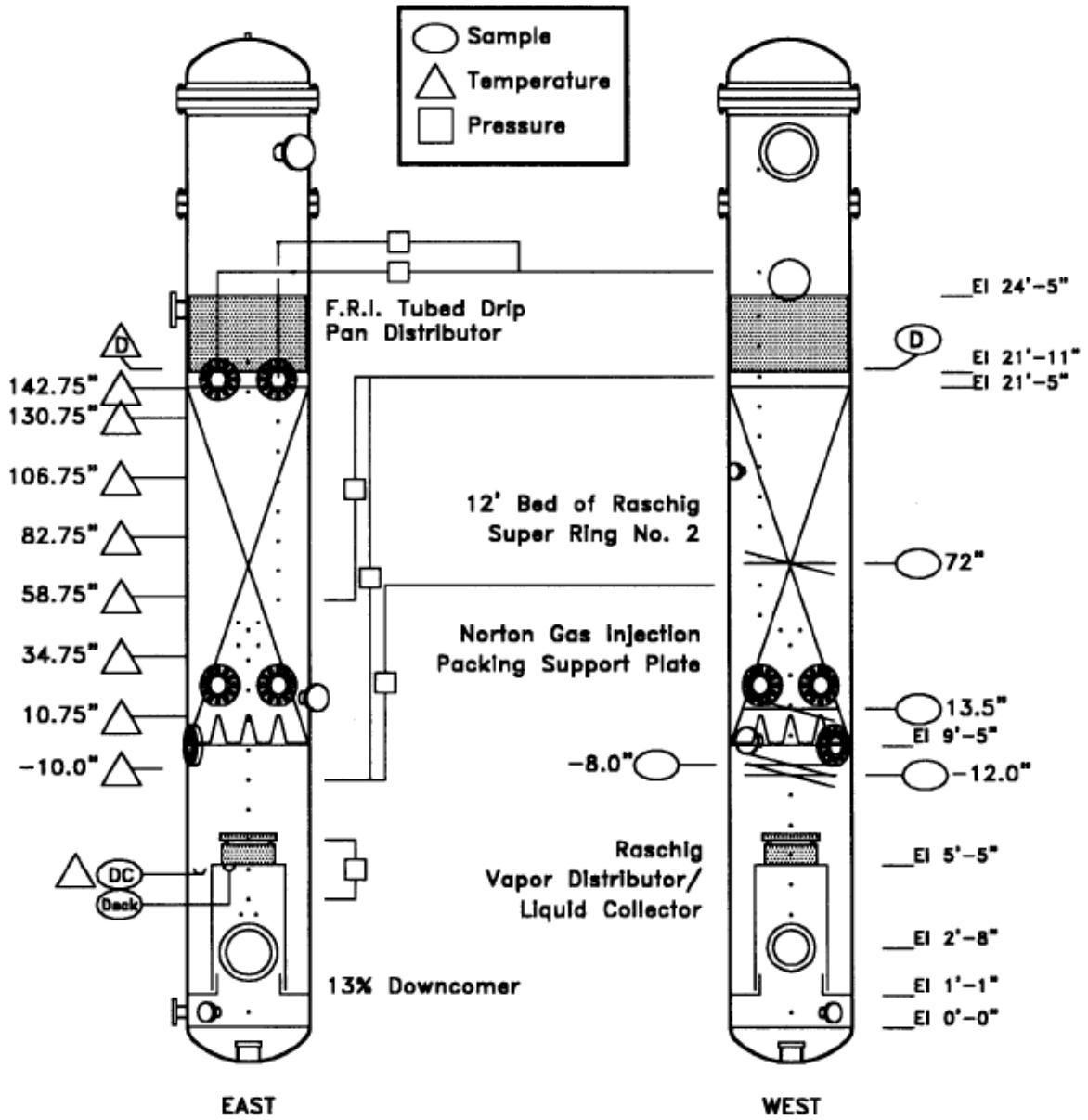
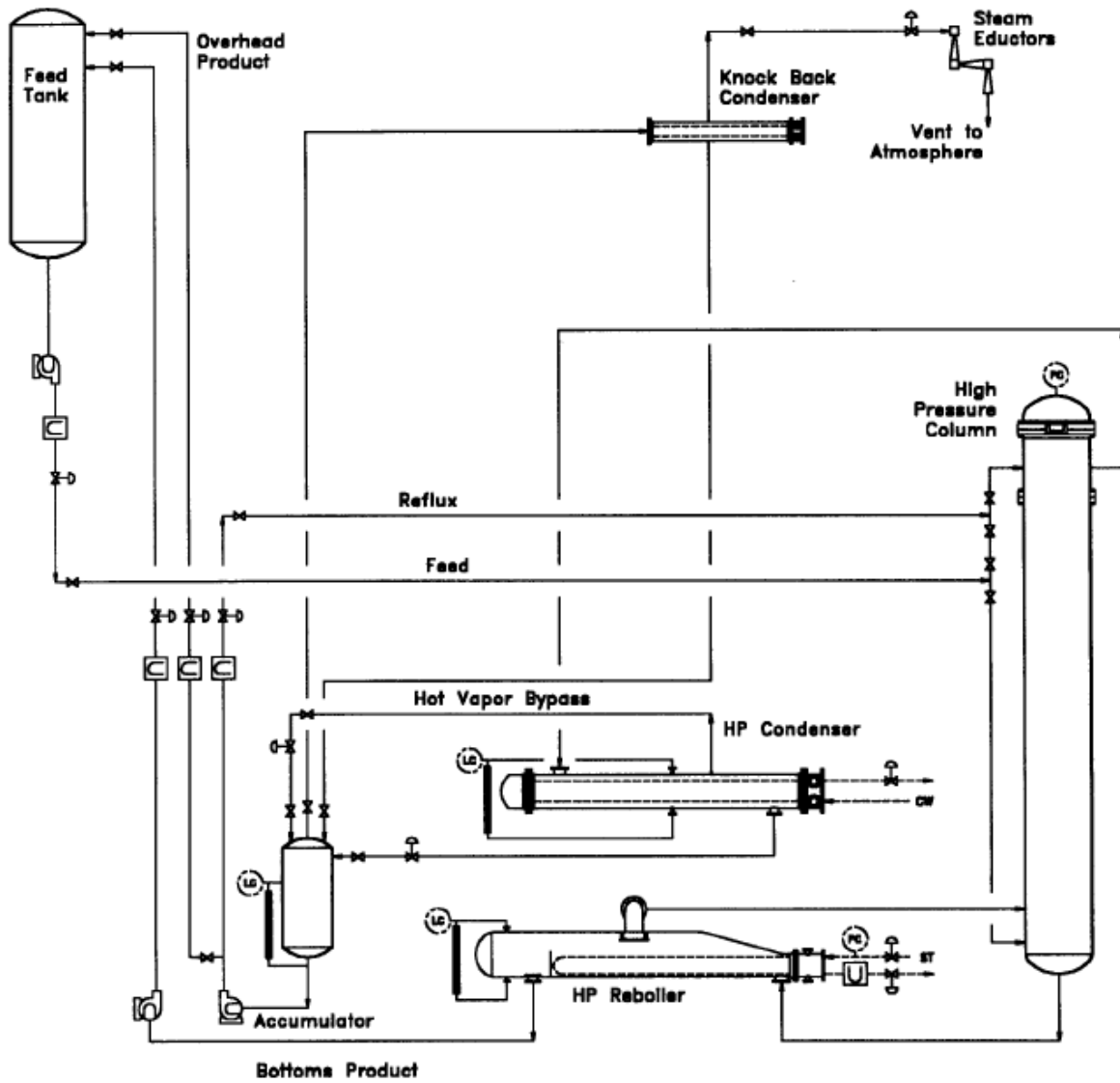


Figure 10. Process Flow Diagram
F.R.I. High Pressure Column



Raschig's interpretation of FRI test result for Raschig Super-Ring No. 2

Summary

In the tests of the Raschig Super-Ring No. 2 the TDP liquid distributor was installed close to the packed bed. The test results show that with large column loads the early acceleration of the gas flow to the flow-receiving side of the liquid distributor and condensation effects due to the cold reflux markedly influence the results in the pressure drop, the mass transfer efficiency and the maximum loading capacity of the Raschig Super-Ring. The test results are therefore not representative in the upper load range.

Interpretation

For the tests of the Raschig Super-Ring No. 2 Raschig GmbH chose the FRI tubed drip pan (TDP) liquid distributor according to Fig. 3 to enable a comparative evaluation of the test results with previous tests, e.g. of 2" Pall rings. At the recommendation of FRI, for the test run the TDP liquid distributor was installed a distance of 152.4 mm to the packed bed. The liquid was applied evenly into the TDP liquid distributor via a nozzle rod according to Fig. 2. The distance of the nozzles to the floor of the liquid distributor was 381 mm for the tests with the system cyclohexane/n-heptane and 406 mm for the system isobutane/n-butane. The height of the liquid distributor was 762 mm.

System: cyclohexane/n-heptane, p=1.65 bar

The Table below shows an extract from the measurement record for the Raschig Super-Ring No. 2 with the system cyclohexane/n-heptane under a pressure of p=1.65 bar. Here the last 12 measuring Runs of the record were shown with increasing vapor and liquid load. Entered are the pressure drop data for both the upper and the lower half of the bed, the liquid level in the liquid distributor, the temperatures of the liquid reflux, the overhead vapor and the liquid in the liquid distributor as well as the gas capacity factor and the HETP value.

It can be seen that up to the measuring Run 19222 the pressure drops of the upper and of the lower dumped packings differ only slightly from one another. The subcooled reflux liquid is atomized via the nozzle distributor into fine drops which make for an effective heat transfer with the adjacent gas. That liquid is only slightly subcooled when it is fed to the dumped packings.

At the measuring Run 19224 the liquid level in the distributor reaches a height of 544 mm so that the nozzle rod is immersed in the liquid layer. Although the gas and liquid load rise only by 5 % the pressure drop of the upper half of the bed increases by 288 % while the lower half of the bed displays a rise of around 17 %. The temperature of the liquid in the liquid distributor falls dramatically by 16 °C, the HETP value increases by 260 % and the liquid hold-up fluctuates.

Spray nozzles height above Distributor floor: 381 mm

Run Number		19220	19221	19223	19222	19224	19225	19227	19226	19228	19229	19209	19208
Run Typ		TR	TR	TR	TR	TR	TR	TR	TR	FT	FT	FT	FT
Pressure Drop													
Bed Top Δp	mbar/m	2.57	2.57	3.65	3.64	10.48	10.53	16.64	14.73	18.16	18.17	18.28	18.07
Bed Bottom Δp	mbar/m	3.11	3.11	5.18	5.19	6.10	6.15	8.35	7.44	12.32	11.92	10.16	10.00
Dist. Pan Bubbler	mm Hot Liq.	327.3	328.1	360.6	360.6	544.0	530.3	779.3	780.8	804.3	803.5	802.8	805.7
Temperature profile													
Reflux	°C	43.8	43.4	42.0	43.1	45.4	45.6	54.8	52.6	46.1	45.6	47.2	46.7
Overhead vapor	°C	101.9	101.8	101.5	101.6	104.9	104.8	105.7	105.3	106.2	106.3	105.8	105.8
Dist. Pan Liquid	°C	94.4	94.4	90.6	90.8	75.1	75.1	79.1	78.5	73.3	73.4	73.3	73.2
Capacity and Efficiency													
F _s	m/s (kg/m ³) ^{0.5}	2.09	2.152	2.239	2.251	2.359	2.365	2.543	2.613	2.835	2.847	2.902	2.904
HETP(Dist.&DC)	m	0.54	0.54	0.51	0.51	1.32	1.33	2.19	1.97	2.35	2.36	2.22	2.37

These abrupt changes in the flow and mass transfer behavior of the Raschig Super-Ring bed can be explained as follows:

The determination of the pressure drop in the upper half of the bed took place independently of the lower half via pressure taps in the column wall. Owing to the reduction of the distance of the liquid distributor to the packed bed to 152.4 mm, the pressure measuring tap with a distance of 120.7 mm above the packed bed was in the direct vicinity of the liquid distributor. The TDP liquid distributor has several gas risers and a ring-shaped gap to the column wall whereby the remaining cross-sectional area for the gas flow is equivalent to 14 % of the cross-sectional area of the column. The gas flow accelerates while passing the liquid distributor to over 7 times the velocity existing below the liquid distributor in the packed bed.

As it is known from fluid-dynamic investigations in severely constricted flows, the vapor flow accelerates already before it reaches the distributor, with the result that the static pressure at the pressure measuring tap just below the distributor drops noticeably and therefore the measured pressure drop rises considerably in the upper half of the bed.

With the aid of video recordings a marked condensation of the flowing saturated steam was observed outside of the cold liquid distributor which was caused by the severely undercooled liquid level in the distributor (the vapor/liquid boiling temperature difference in the system studied is 2 °C). The condensate was accumulating caused by the high gas velocities outside of the distributor and a periodically raining downward of the condensate could be seen. The flow and concentration profile within the packed bed was consequently so disturbed that a drastic drop in mass transfer efficiency respectively a marked rise in the HETP value occurred.

This operating behavior persisted as the column load increased and was increased even more from the measuring Run 19228 as a result of the overflow of the liquid distributor.

Taking these considerations into account, the pressure drop of the packed bed from measuring Run 19224 takes place at a lower pressure level than the mean pressure drop shown in Fig. 14 and the HETP values still assume low values until shortly before the flooding point. On the basis of the existing experience of operation the measuring point with the greatest column load (Run 19208) is only slightly below the flooding point of the Raschig Super-Ring No. 2.

System: isobutane/n-butane, p=11.4 bar

The measuring results in the system isobutane/n-butane with the pressure 11.4 bar are analogous, acc. Table below. Since the temperature level of the boiling butane mixture is on the whole lower than in the system cyclohexane/n-heptane, the temperature differences show less change. An increase of the column load by 2 % from measuring Runs 19247 to 19266 increases the pressure drop of the upper half of the bed by 26 % while the pressure drop of the lower half of the bed decreases by 8 % and the liquid hold-up becomes unstable.. Also in this test system the temperature of the liquid in the distributor decreases by 4 °C at measuring Run 19266. A visibly marked condensation of saturated steam outside of the liquid distributor due to the cool liquid level in the distributor was observed from measuring Run 19249. The HETP values consequently rise considerably. The apparently small temperature differences gain in importance if one takes into account that the vapor/liquid boiling temperature difference in the observed system is only 0.6 °C.

Spray nozzles height above Distributor floor: 406 mm

Run Number		19239	19238	19245	19244	19246	19247	19266	19267	19249	19248	19231	19230
Run Typ		TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	FT	FT
Pressure Drop													
Bed Top Δp	mbar/m	4.14	4.13	5.24	5.49	7.79	7.53	9.49	9.62	8.45	8.44	10.92	10.84
Bed Bottom Δp	mbar/m	4.14	4.15	4.29	4.54	5.53	5.62	5.19	5.32	4.93	5.00	6.14	6.12
Dist. Pan Bubbler	mm Hot Liq.	299.6	299.4	353.0	358.8	378.7	377.3	356.5 *	349.5 *	480.5	466.2	573.3	572.9
Reflux	°C	51.0	52.7	61.0	60.6	55.9	56.7	38.9	36.4	66.6	64.9	57.8	58.4
Overhead vapor	°C	77.7	77.4	76.2	76.2	78.3	78.3	78.9	78.4	79.0	78.9	78.4	78.3
Dist. Pan Liquid	°C	70.4	70.3	72.6	72.4	71.3	71.6	67.4	67.3	71.4	70.2	65.9	66.1
F _s	m/s (kg/m ³) ^{0.5}	1.42	1.425	1.505	1.514	1.586	1.593	1.622	1.636	1.710	1.710	1.816	1.819
HETP(Dist.&DC)	m	0.41	0.42	0.45	0.45	0.52	0.52	1.20	0.79	2.07	2.15	2.65	2.79

* drop in distributor level is unexplainable

A further indication that the Raschig Super-Ring No. 2 was not operated at its load limit is the measured pressure drops of measuring Runs 19231 and 19230. While the flooding point based on FRI assumption occurred in modern packed columns at a pressure drop of approx. 15 mbar/m the Raschig Super-Ring bed was operated with a mean of only 8.49 mbar/m and the lower half of the bed was operated only up to 6.12 mbar/m. This is equivalent only to 57 % and 41 % respectively of the pressure drop at the flooding point. The flooding point of the Raschig Super-Ring is therefore above the examined maximum column load.

System: isobutane/n-butane, p=6.89 bar

The described relationships also show up in the test system isobutane/n-butane with a pressure of 6.89 bar to an early drop in the mass transfer efficiency of the FRI test column as measuring Runs 19264 and 19262 show. Again the pressure drop in the upper half of the bed shows considerably higher values than in the lower half of the bed since the nozzle rod immerses into the liquid layer of the distributor. Since this system operates at lower temperature levels, a severe drop in the temperature of the liquid in the distributor can no longer be seen but the liquid hold-up varies. The video recordings, however,

display a marked formation of mist from the column load with the measuring Run 19262 which also suggests condensation from saturated vapor. The vapor/liquid boiling temperature difference in the system observed is 0.7 °C. The marked formation of mist completely prevented an objective observation of the processes between the liquid distributor and the packed bed.

Spray nozzles height above Distributor floor: 406 mm

Run Number		19257	19256	19258	19259	19260	19261	19265	19264	19262	19263	19250	19251
Run Typ		TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	FT	FT
Pressure Drop													
Bed Top Δp	mbar/m	1.38	1.37	3.48	3.46	6.22	6.00	7.89	8.52	9.72	9.71	10.57	9.45
Bed Bottom Δp	mbar/m	1.22	1.24	2.97	2.94	5.39	5.34	5.87	5.92	5.68	5.65	5.71	5.84
Dist. Pan Bubbler	mm Hot Liq.	106.1	105.0	214.3	213.8	294.1	286.6	296.6	307.7	400.7	404.9	503.1	441.1
Reflux	°C	44.6	45.4	29.4	29.0	48.3	46.8	35.8	39.1	47.8	47.3	51.5	49.4
Overhead vapor	°C	55.6	55.2	53.7	53.3	55.6	55.5	56.3	56.4	58.9	58.5	57.8	57.1
Dist. Pan Liquid	°C	52.8	52.8	48.1	48.1	55.3	55.1	53.8	55.0	55.1	55.0	54.8	53.7
F_s	m/s (kg/m ³) ^{0.5}	1.226	1.228	1.667	1.669	1.850	1.853	1.886	1.889	1.926	1.937	2.052	2.065
HETP(Dist.&DC)	m	0.50	0.50	0.47	0.47	0.46	0.49	0.57	0.54	1.52	1.82	1.93	2.43

The measured pressure drop at maximum column load (measuring Run 19251) is 7.65 mbar/m on average and 5.84 mbar/m for the lower half of the bed. This is equivalent only to 51 % and 39 % respectively of the pressure drop at the flooding point which is confirmed with 15 mbar/m by FRI tests conducted elsewhere. The flooding point of the Raschig Super-Ring is therefore also in these tests considerably above the operated column load.

Finally the following progress report for Mellapak 250 Y from November-December 1987 by T. Yanagi, L. Lahn, J. Kunesh is cited which again confirms the conditions described above (capture: Appearance of Froth Build Up on Top of Bed):

"With the butane system, if the distributor had been installed closer than present 18 inches above the bed, it is likely that the packing would have gone into a premature flood triggered by the froth reaching the bottom of the distributor and being educated up through the vapor chimneys. On the other hand, if the distance between the distributor and the bed had been greater than 18 inches (457 mm) the operating range have been extended even further before the bed separation deteriorated."

Annex:

We would like to thank Dr. Kunesh and all the staff at FRI for their willingness to engage in discussion and their kind assistance in carrying out the tests, and in particular Dr. Cai who was responsible for the proper execution of the tests and their evaluation. Our thanks also go Dr. Fitz who supervised and elaborated the hold-up measurements.

Table I (English Units)
 F.R.I. 4 Foot Diameter High Pressure Column
 Raschig-Super Ring No. 2, 12 Foot Packing Depth, F.R.I. TDP Distributor (6.5 mm Tubes)
 Cyclohexane/n-Heptane System, 24 psia

Run Number	19214	19215	19217	19216	19213	19212	19219	19218	19220	19221
Run Type	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR
Column Top Pressure, psia	23.98	23.98	23.99	23.98	23.97	23.97	24.00	24.00	23.98	23.98
Reboiler Duty, M Btu/h	1.69	1.69	3.38	3.39	4.24	4.24	5.10	5.10	6.21	6.21
Condenser Duty, M Btu/h	1.46	1.52	3.13	3.20	3.97	3.95	4.81	4.93	5.91	5.92
Heat Loss, M Btu/h	0.15	0.14	0.14	0.13	0.15	0.16	0.16	0.15	0.15	0.16
Reflux Flow Rate, k lb/h	7.56	7.71	17.25	17.26	21.33	21.40	26.92	27.06	32.96	32.95
Feed Rate, k lb/h	59.98	59.98	60.00	59.98	59.99	59.96	59.99	59.98	59.99	59.95
Feed Location	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom
Pressure Drops:										
Overall (144 inch), inch H ₂ O/ft	0.01	0.01	0.06	0.06	0.10	0.10	0.18	0.18	0.37	0.37
Top (73 inch), inch H ₂ O/ft	0.01	0.01	0.06	0.06	0.09	0.09	0.16	0.16	0.31	0.31
Bottom (77 inch), inch H ₂ O/ft	0.01	0.01	0.07	0.08	0.09	0.09	0.16	0.16	0.38	0.38
Liq. Dist., inch H ₂ O			0.16	0.15	0.33	0.33	0.62	0.62	0.80	0.80
Vap. Dist., inch H ₂ O			0.14	0.13	0.29	0.29	0.48	0.49	0.83	0.83
Head in Liq. Dist., inch Hot Liq.	0.58	0.60	2.65	2.59	5.10	5.12	8.70	8.76	12.88	12.92
Temperature Profile, (°F):										
Accumulator Tank	91.9	92.2	100.1	100.9	102.5	102.2	107.1	108.4	109.8	109.0
Reflux	98.9	98.5	104.4	105.4	104.1	104.1	110.2	110.5	110.9	110.2
Overhead Vapor	216.3	216.4	216.1	216.2	216.2	216.2	216.5	216.5	215.4	215.3
Liq. Dist.	208.5	208.3	205.7	206.5	208.4	208.0	207.4	207.3	201.9	202.0
142.75 inches*	214.8	214.8	214.9	215.2	215.3	215.5	216.0	216.0	214.9	214.9
130.75 inches	219.1	218.0	214.7	215.0	215.1	214.9	216.4	216.3	216.0	216.0
106.75 inches	223.5	223.4	218.3	218.6	219.1	218.9	220.1	220.1	219.6	219.9
82.75 inches	226.0	227.8	221.1	221.8	222.3	222.8	223.4	223.3	224.1	224.2
58.75 inches	231.9	230.4	224.7	224.8	226.4	227.1	227.3	227.6	229.2	228.2
34.75 inches	231.1	230.8	229.2	229.7	229.7	230.1	230.2	230.5	230.6	230.9
10.75 inches	233.4	233.3	232.8	232.6	232.7	232.2	232.6	232.9	233.7	233.8
-10.00 inches	234.1	234.4	233.8	233.8	234.1	234.2	234.3	234.3	235.5	235.5
Vap. Dist./Liq. Collector	231.7	231.7	233.7	233.7	233.2	233.3	233.8	233.7	234.3	234.2
Reboiler Vapor	236.4	236.4	236.9	236.8	236.4	236.5	237.1	237.1	237.5	237.4
Bottoms from Reboiler	236.3	236.1	237.1	237.1	236.7	236.8	237.7	237.6	238.1	238.3
Feed	232.3	232.4	233.5	233.7	232.7	232.6	233.6	233.8	234.1	234.0
Liquid to Reboiler	235.8	235.8	236.6	236.6	235.9	235.9	236.8	236.9	237.3	237.3
Composition of Liquid, (mol% C₆):										
Reflux	76.66	76.37	77.50	77.52	74.87	75.41	75.23	75.17	75.25	75.04
Liq. Dist.	75.53	75.02	76.44	76.64	75.24	74.24	73.59	73.95	74.13	74.10
Mid Point 72 inches*	43.32	40.11	49.01	48.00	51.08	43.22	45.14	43.84	40.05	41.07
13.25 inches	17.67	18.76	22.38	22.79	22.11	20.60	23.13	21.19	17.14	16.59
-8.00 inches	14.84	14.29	17.07	16.65	16.35	15.71	16.43	15.83	12.72	12.41
-12.00 inches	14.17	16.01	17.59	16.73	16.27	17.30	17.03	17.37	13.41	12.96
Vap. Dist./Liq. Collector	16.36	14.21	16.00	15.38	14.35	15.33	14.88	14.81	11.93	11.88
Downcomer	13.06	13.47	15.04	14.33	12.82	14.09	13.96	13.98	12.24	12.31
Bottom	9.99	10.01	9.96	9.86	9.69	9.43	10.17	10.08	8.54	8.61
Feed	10.32	10.33	10.09	10.03	9.82	9.86	10.23	10.15	8.75	8.72
Conditions @ 72 inch Based on Reboiler Duty:										
Temperature, °F	229.5	229.2	222.6	222.9	224.2	224.9	225.3	225.4	226.8	226.2
Vapor Density, lb/ft ³	0.345	0.340	0.319	0.319	0.328	0.323	0.327	0.326	0.329	0.329
Liquid Density, lb/ft ³	39.51	39.36	40.07	40.00	40.12	39.68	39.76	39.69	39.44	37.86
Vapor Flow Rate, k lb/h	11.19	11.30	23.23	23.38	29.27	29.44	35.64	35.77	44.00	45.34
Liquid Flow Rate, gpm	35.31	35.81	72.26	72.86	90.95	92.49	111.73	112.34	139.08	149.30
F _s , ft/s(lb/ft ³) ^{0.5}	0.426	0.433	0.918	0.924	1.140	1.156	1.391	1.398	1.713	1.764
Capacity Factor, C _s , ft/s	0.068	0.069	0.146	0.147	0.181	0.184	0.222	0.223	0.274	0.288
Pressure Drop, inch H ₂ O/ft	0.01	0.01	0.06	0.06	0.10	0.10	0.18	0.18	0.37	0.37
HETP (Dist. & Below Bed), inches	22.0	22.7	23.5	23.0	23.3	24.0	24.4	24.2	21.8	21.6
HETP (Dist. & DC), inches	21.1	21.6	22.1	21.6	21.2	22.5	22.6	22.4	21.3	21.3
Relative Volatility	1.558	1.559	1.563	1.563	1.560	1.564	1.561	1.562	1.562	1.563

* Elevation Above Support Plate

Table I (English Units) (Cont'd)
 F.R.I. 4 foot Diameter High Pressure Column
 Raschig-Super Ring No. 2, 12 Foot Packing Depth, F.R.I. TDP Distributor (6.5 mm Tubes)
 Cyclohexane/n-Heptane System, 24 psia

Run Number	19223	19222	19224	19225	19227	19226	19228	19229	19209	19208
Run Type	TR	TR	TR	TR	TR	TR	FT	FT	FT	FT
Column Top Pressure, psia	23.98	23.98	23.97	24.00	23.99	23.99	24.06	24.13	24.02	24.01
Reboiler Duty, M Btu/h	6.76	6.75	7.04	7.05	7.64	7.64	8.48	8.48	8.51	8.50
Condenser Duty, M Btu/h	6.37	6.41	6.81	6.83	7.58	7.54	8.21	8.19	8.21	8.23
Heat Loss, M Btu/h	0.21	0.22	0.19	0.19	0.12		0.16	0.16	0.11	0.10
Reflux Flow Rate, k lb/h	35.21	35.32	39.45	37.69	44.33	44.20	46.68	46.44	47.22	47.36
Feed Rate, k lb/h	59.99	60.00	60.00	60.01	59.99	59.99	59.96	59.99	41.95	41.96
Feed Location	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom
Pressure Drops:										
Overall (144 inch), inch H ₂ O/ft	0.57	0.57	1.04	1.05	1.58	1.37	1.93	1.91	1.80	1.79
Top (73 inch), inch H ₂ O/ft	0.45	0.45	1.28	1.29	2.04	1.80	2.22	2.23	2.24	2.21
Bottom (77 inch), inch H ₂ O/ft	0.63	0.64	0.75	0.75	1.02	0.91	1.51	1.46	1.24	1.22
Liq. Dist., inch H ₂ O	0.84	0.83	1.97	2.00	3.66	3.42	4.85	4.71	4.66	4.68
Vap. Dist., inch H ₂ O	0.87	0.86	0.90	0.91	1.05	1.07	3.87	3.72	2.29	2.33
Head in Liq. Dist., inch Hot Liq.	14.20	14.20	21.42	20.88	30.68	30.74	31.66	31.63	31.61	31.72
Temperature Profile, (°F):										
Accumulator Tank	107.0	108.6	113.4	113.7	130.0	128.5	114.0	113.1	116.2	115.4
Reflux	107.6	109.5	113.7	114.0	130.6	126.7	114.9	114.0	116.9	116.0
Overhead Vapor	214.7	214.8	220.8	220.7	222.3	221.5	223.2	223.3	222.4	222.4
Liq. Dist.	195.1	195.5	167.1	167.2	174.4	173.3	163.9	164.1	164.0	163.8
142.75 inches*	214.2	214.3	220.5	220.4	226.3	222.7	225.4	225.3	225.5	225.6
130.75 inches	215.9	216.1	223.0	223.4	224.6	222.6	225.4	225.4	224.9	224.8
106.75 inches	220.0	219.9	226.1	226.1	224.3	222.8	225.7	225.6	225.1	225.0
82.75 inches	225.5	225.5	227.7	227.8	224.7	222.7	225.7	225.7	225.1	225.0
58.75 inches	229.8	230.1	231.6	231.7	227.9	224.8	226.4	226.3	226.7	226.6
34.75 inches	232.6	232.7	230.3	230.5	230.0	229.7	228.5	228.7	229.5	229.5
10.75 inches	234.7	234.9	231.6	231.7	230.4	230.3	229.2	229.4	229.6	228.8
-10.00 inches	236.4	236.3	233.9	234.1	231.5	230.6	229.7	230.1	231.2	231.1
Vap. Dist./Liq. Collector	235.2	235.4	232.8	232.8	227.7	227.4	231.1	231.1	228.4	228.4
Reboiler Vapor	238.3	238.5	235.8	235.8	233.1	232.8	235.8	235.9	233.3	233.3
Bottoms from Reboiler	238.9	239.0	236.4	236.6	234.0	233.7	236.9	236.9	234.2	233.9
Feed	233.4	233.4	231.3	231.5	230.7	230.6	232.5	232.4	229.9	230.1
Liquid to Reboiler	237.8	238.0	235.0	235.1	232.5	232.4	235.1	235.2	232.4	232.5
Composition of Liquid, (mol% C₆):										
Reflux	76.62	76.51	58.47	57.99	50.78	52.27	49.73	49.84	48.81	48.86
Distributor	75.34	75.53	54.50	54.83	46.86	48.84	46.83	46.58	46.09	46.44
Mid Point 72 inches*	41.70	38.37	33.27	32.60	49.45	45.50	47.05	45.86	41.97	41.94
13.25 inches	11.45	11.77	20.76	20.27	31.47	32.64	39.04	39.97	39.68	38.70
-8.00 inches	11.14	11.42	21.45	20.77	28.99	29.49	37.77	35.24	30.67	30.46
-12.00 inches	11.44	11.35	22.78	21.39	29.14	30.33	35.62	34.69	29.14	30.67
Vap. Dist./Liq. Collector	10.02	10.26	20.53	20.43	40.64	30.27	30.24	29.59	33.60	33.65
Downcomer	11.18	11.05	25.89	26.26	29.62	29.39	30.63	30.50	29.03	30.38
Bottom	7.53	7.52	16.53	16.68	26.23	25.05	29.00	27.06	27.01	26.79
Feed	7.69	7.62	16.77	16.59	25.50	25.21	25.24	25.12	27.37	27.25
Conditions @ 72 inch Based on Reboiler Duty:										
Temperature, °F	227.6	227.8	230.1	230.2	226.3	223.3	225.8	225.7	225.7	225.6
Vapor Density, lb/ft ³	0.334	0.332	0.336	0.336	0.336	0.319	0.332	0.330	0.326	0.325
Liquid Density, lb/ft ³	39.50	39.32	38.98	38.94	39.96	39.85	39.84	39.78	39.58	39.58
Vapor Flow Rate, k lb/h	47.53	47.58	50.22	50.32	54.12	54.16	59.94	60.04	60.80	60.80
Liquid Flow Rate, gpm	150.01	150.85	160.63	161.10	168.84	169.41	187.53	188.14	191.48	191.49
F _S , ft/s(lb/ft ³) ^{0.5}	1.835	1.845	1.934	1.938	2.084	2.142	2.324	2.334	2.379	2.380
Capacity Factor, C _S , ft/s	0.293	0.295	0.311	0.312	0.331	0.341	0.370	0.372	0.380	0.380
Pressure Drop, inch H ₂ O/ft	0.57	0.57	1.04	1.05	1.58	1.37	1.93	1.91	1.80	1.79
HETP (Dist. & Below Bed), inches	20.2	20.2	44.6	42.4	83.3	79.8	154.4	132.1	92.2	94.5
HETP (Dist. & DC), inches	20.1	20.0	52.1	52.4	86.3	77.4	92.5	93.0	86.7	93.3
Relative Volatility	1.561	1.562	1.562	1.562	1.558	1.562	1.558	1.558	1.559	1.560

* Elevation Above Support Plate

Table II (English Units)
 F.R.I. 4 Foot Diameter High Pressure Column
 Raschig-Super Ring No. 2, 12 Foot Packing Depth, F.R.I. TDP Distributor (10 mm Tubes)
Isobutane/Normal Butane System, 165 psia

Run Number	19233	19232	19242	19243	19235	19234	19236	19237	19239	19238
Run Type	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR
Column Top Pressure, psia	164.83	165.23	165.04	165.36	165.26	165.06	165.28	165.18	164.92	164.92
Reboiler Duty, M Btu/h	2.17	2.17	3.56	3.56	4.31	4.31	6.46	6.46	8.60	8.58
Condenser Duty, M Btu/h	2.26	2.32	3.44	3.49	4.17	4.50	6.20	6.33	8.24	8.47
Heat Loss, M Btu/h	0.07	0.09	0.23	0.20	0.18	0.11	0.06	0.05	0.20	0.17
Reflux Flow Rate, k lb/h	14.36	14.38	21.81	22.19	29.15	29.95	44.55	44.29	60.66	60.68
Feed Rate, k lb/h	59.98	60.04	59.97	60.00	60.05	59.97	60.00	59.96	59.70	63.65
Feed Location	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom
Pressure Drops:										
Overall (144 inch), inch H ₂ O/ft	0.05	0.05	0.07	0.08	0.09	0.09	0.23	0.23	0.50	0.50
Top (73 inch), inch H ₂ O/ft	0.04	0.04	0.07	0.07	0.10	0.09	0.23	0.23	0.51	0.51
Bottom (77 inch), inch H ₂ O/ft	0.01	0.02	0.00	0.01	0.10	0.10	0.21	0.21	0.51	0.51
Liq. Dist., inch H ₂ O	0.13	0.14	0.27	0.27	0.28	0.28	0.51	0.50	0.69	0.69
Vap. Dist., inch H ₂ O	0.11	0.10	0.20	0.22	0.12	0.12	0.40	0.41	0.55	0.60
Head in Liq. Dist., inch Hot Liq.	0.92	0.94	1.63	1.71	2.19	2.32	6.75	6.73	11.79	11.79
Temperature Profile, (°F):										
Accumulator Tank	114.8	113.7	99.3	97.1	113.2	116.4	113.1	110.1	124.4	127.0
Reflux	114.7	113.8	97.7	95.5	113.1	115.9	112.7	109.9	123.8	126.8
Overhead Vapor	170.3	170.2	166.9	166.8	167.6	167.9	167.1	166.8	171.8	171.4
Liq. Dist.	167.6	167.0	160.8	160.7	160.0	160.1	158.3	158.6	158.7	158.6
142.75 inches*	168.6	169.3	166.6	166.0	167.3	167.5	167.1	166.9	172.2	171.8
130.75 inches	169.0	169.0	169.2	168.6	168.9	168.5	169.0	168.6	173.9	173.7
106.75 inches	170.3	170.4	172.4	172.0	172.8	172.6	172.0	171.7	176.5	176.4
82.75 inches	170.6	170.8	173.5	173.2	173.6	175.0	173.7	173.4	178.6	178.5
58.75 inches	173.0	173.0	177.2	176.4	177.5	177.5	179.2	179.1	181.0	180.9
34.75 inches	174.2	174.4	175.6	175.0	176.3	175.9	175.6	175.2	180.5	180.5
10.75 inches	176.1	176.5	176.9	176.4	177.7	178.3	177.7	177.3	182.5	182.0
-10.00 inches	179.9	177.9	181.3	181.4	182.2	182.1	183.0	183.0	184.4	184.0
Vap. Dist./Liq. Collector	178.1	178.2	178.4	178.1	179.6	179.7	178.6	178.2	182.7	182.7
Reboiler Vapor	184.9	184.1	184.2	184.4	186.4	186.0	185.5	185.2	190.1	188.9
Bottoms from Reboiler	183.0	183.0	183.9	183.5	185.7	184.8	184.6	184.6	189.2	188.2
Feed	180.6	180.9	178.4	178.6	181.3	182.2	183.2	183.4	184.4	184.5
Liquid to Reboiler	182.6	183.0	181.8	181.7	184.8	183.4	183.6	183.3	186.6	186.6
Composition of Liquid, (mol %iC₄):										
Reflux	47.76	47.54	56.05	55.91	58.08	57.48	54.09	54.01	51.20	49.11
Liq. Dist.	46.94	46.70	54.97	55.46	57.57	57.04	53.87	53.82	51.86	48.71
Mid Point 72 inches*	35.81	33.13	32.34	34.06	37.06	37.37	33.44	33.09	30.52	28.58
13.25 inches	31.12	31.68	24.31	25.31	26.25	25.85	22.38	22.96	16.03	14.84
-8.00 inches	26.53	26.77	21.47	21.65	22.30	21.71	19.52	19.53	15.21	13.77
-12.00 inches	27.57	27.38	22.57	21.46	22.14	21.77	19.85	19.87	15.94	14.17
Vap. Dist./Liq. Collector	25.28	25.35	20.30	20.72	20.93	20.94	19.53	19.31	14.48	13.56
Downcomer	26.40	26.13	21.16	21.41	21.75	21.40	20.17	20.03	15.22	14.03
Bottom	22.16	22.11	17.21	17.19	17.95	17.71	16.74	16.75	12.59	12.03
Feed	22.09	22.09	17.33	17.21	17.96	17.71	16.74	16.76	13.00	11.93
Conditions @ 72 inch Based on Reboiler Duty:										
Temperature, °F	171.8	171.9	175.8	175.2	176.0	176.6	177.3	177.1	180.0	179.9
Vapor Density, lb/ft ³	1.680	1.664	1.746	1.743	1.780	1.796	1.786	1.780	1.829	1.814
Liquid Density, lb/ft ³	30.73	30.78	30.58	30.58	30.47	30.43	30.47	30.49	30.37	30.42
Vapor Flow Rate, k lb/h	17.02	17.04	27.66	27.87	34.51	35.22	53.53	53.54	70.52	70.45
Liquid Flow Rate, gpm	69.04	69.03	112.78	113.64	141.19	144.30	219.00	218.93	289.43	288.73
F _s , ft/s(lb/ft ³) ^{0.5}	0.293	0.295	0.467	0.471	0.578	0.587	0.894	0.896	1.164	1.168
Capacity Factor, C _s , ft/s	0.054	0.055	0.087	0.088	0.108	0.110	0.167	0.167	0.218	0.218
Pressure Drop, inch H ₂ O/ft	0.05	0.05	0.07	0.08	0.09	0.09	0.23	0.23	0.50	0.50
HETP (Dist. & Below Bed), inches	32.8	33.3	19.8	19.2	18.4	18.3	18.6	18.6	16.4	16.6
HETP (Dist. & DC), inches	31.8	31.6	19.2	19.2	18.1	18.1	18.9	18.9	16.3	16.7
Relative Volatility	1.237	1.237	1.235	1.235	1.233	1.232	1.233	1.234	1.229	1.230

* Elevation Above Support Plate

Table II (English Units) (Cont'd)
 F.R.I. 4 foot Diameter High Pressure Column
 Raschig-Super Ring No. 2, 12 Foot Packing Depth, F.R.I. TDP Distributor (10 mm Tubes)
 Isobutane/Normal Butane System, 165 psia

Run Number	19245	19244	19246	19247	19266	19267	19249	19248	19231	19230
Run Type	TR	TR	TR	TR	TR	TR	TR	TR	FT	FT
Column Top Pressure, psia	165.35	165.28	165.27	165.47	165.34	165.42	165.42	165.21	165.69	165.09
Reboiler Duty, M Btu/h	9.01	9.01	9.56	9.56	9.69	9.69	10.14	10.14	10.77	10.78
Condenser Duty, M Btu/h	9.02	9.14	9.15	8.95	8.38	9.85	10.46	10.31	10.37	10.41
Heat Loss, M Btu/h	0.13	0.08	0.19	0.15	0.10	0.03	0.04	0.04	0.07	0.07
Reflux Flow Rate, k lb/h	68.82	69.16	69.58	69.47	61.96	60.83	79.17	78.41	79.99	80.04
Feed Rate, k lb/h	59.99	59.95	60.04	59.99	60.02	59.86	59.98	60.00	59.97	59.96
Feed Location	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom
Pressure Drops:										
Overall (144 inch), inch H ₂ O/ft	0.61	0.64	0.85	0.84	0.91	0.92	0.85	0.85	1.05	1.04
Top (73 inch), inch H ₂ O/ft	0.64	0.67	0.95	0.92	1.16	1.18	1.03	1.03	1.34	1.33
Bottom (77 inch), inch H ₂ O/ft	0.53	0.56	0.68	0.69	0.64	0.65	0.60	0.61	0.75	0.75
Liq. Dist., inch H ₂ O	0.75	0.79	0.89	0.89	1.17	1.14	1.42	1.43	1.93	1.90
Vap. Dist., inch H ₂ O	0.53	0.57	0.70	0.71	0.65	0.63	0.70	0.71	0.71	0.71
Head in Liq. Dist., inch Hot Liq.	13.90	14.12	14.91	14.85	14.04	13.76	18.92	18.35	22.57	22.56
Temperature Profile, (°F):										
Accumulator Tank	143.3	142.2	134.5	135.0	101.9	97.4	153.2	149.8	136.2	137.2
Reflux	141.8	141.1	132.7	134.0	102.0	97.6	151.9	148.9	136.1	137.1
Overhead Vapor	168.9	169.2	173.0	173.0	174.0	173.2	174.2	174.1	173.2	173.0
Liq. Dist.	162.7	162.3	160.3	160.8	153.3	153.1	160.5	158.3	150.7	151.0
142.75 inches*	169.3	169.7	173.3	173.3	174.3	173.6	173.6	173.5	172.9	172.4
130.75 inches	171.3	171.5	174.9	175.0	176.9	176.3	176.4	176.2	175.2	174.7
106.75 inches	173.2	173.4	178.0	177.1	178.5	177.6	178.0	178.1	174.7	174.3
82.75 inches	176.4	176.7	179.7	179.6	179.7	178.7	178.4	178.3	175.6	175.4
58.75 inches	181.4	181.5	182.4	182.3	183.5	183.5	181.7	181.8	180.6	180.0
34.75 inches	177.5	177.7	181.2	180.4	179.6	180.6	178.7	178.5	177.3	177.0
10.75 inches	178.5	179.3	182.4	181.8	182.4	181.3	180.4	179.7	177.8	177.9
-10.00 inches	185.5	185.8	185.1	184.7	185.0	186.5	185.7	184.7	182.0	181.8
Vap. Dist./Liq. Collector	180.6	180.7	181.7	181.8	179.5	180.4	178.7	178.6	176.3	176.0
Reboiler Vapor	186.1	186.3	189.0	188.2	186.6	186.4	184.3	184.5	183.5	183.2
Bottoms from Reboiler	185.5	185.7	188.4	187.8	186.1	185.5	183.8	183.9	183.1	183.0
Feed	182.4	183.9	183.9	184.3	183.8	184.9	182.8	182.9	181.5	181.2
Liquid to Reboiler	183.7	183.9	186.6	185.9	184.5	184.1	182.1	182.1	180.1	179.8
Composition of Liquid, (mol %iC₄):										
Reflux	50.66	49.99	43.21	43.62	29.21	31.78	31.98	32.06	36.46	36.63
Distributor	49.93	49.72	43.25	43.36	29.25	30.89	31.59	31.61	35.87	35.95
Mid Point 72 inches*	27.41	27.30	20.21	20.91	16.89	16.54	24.37	25.12	31.11	31.73
13.25 inches	15.38	15.43	14.28	14.36	14.60	15.29	22.04	21.79	28.22	27.45
-8.00 inches	14.93	15.17	14.20	14.31	14.47	14.47	21.87	21.77	27.78	27.24
-12.00 inches	15.64	15.90	13.93	14.09	15.12	13.95	21.66	21.77	27.73	27.61
Vap. Dist./Liq. Collector	15.34	15.20	14.43	14.60	15.26	14.44	22.87	22.60	26.65	28.77
Downcomer	15.93	15.85	15.32	15.29	18.38	14.85	24.67	24.88	30.23	30.60
Bottom	13.04	12.98	12.83	12.71	13.41	12.44	19.75	19.98	25.23	25.35
Feed	13.19	13.04	12.78	12.92	13.62	12.98	19.80	19.87	25.37	25.29
Conditions @ 72 inch Based on Reboiler Duty:										
Temperature, °F	179.7	179.9	181.4	181.4	182.4	181.8	180.7	180.7	178.9	178.4
Vapor Density, lb/ft ³	1.802	1.805	1.792	1.796	1.792	1.778	1.803	1.809	1.806	1.800
Liquid Density, lb/ft ³	30.45	30.45	30.51	30.50	30.53	30.57	30.46	30.45	30.43	30.44
Vapor Flow Rate, k lb/h	74.18	74.65	77.94	78.36	79.69	80.06	84.29	84.40	89.59	89.56
Liquid Flow Rate, gpm	303.66	305.67	318.47	320.33	325.43	326.54	344.94	345.56	367.07	366.79
F _S , ft/s(lb/ft ³) ^{0.5}	1.234	1.241	1.300	1.306	1.329	1.341	1.402	1.401	1.489	1.491
Capacity Factor, C _S , ft/s	0.231	0.232	0.243	0.244	0.248	0.250	0.262	0.262	0.278	0.279
Pressure Drop, inch H ₂ O/ft	0.61	0.64	0.85	0.84	0.91	0.92	0.85	0.85	1.05	1.04
HETP (Dist. & Below Bed), inches	17.3	17.6	19.2	19.3	33.5	29.4	56.2	56.2	72.8	69.4
HETP (Dist. & DC), inches	17.8	17.8	20.5	20.5	47.3	31.1	81.4	84.7	104.4	109.8
Relative Volatility	1.233	1.232	1.230	1.231	1.230	1.231	1.231	1.231	1.231	1.232

* Elevation Above Support Plate

Table III (English Units)
 F.R.I. 4 Foot Diameter High Pressure Column
 Raschig-Super Ring No. 2, 12 Foot Packing Depth, F.R.I. TDP Distributor (10 mm Tubes)
 Isobutane/Normal Butane System, 100 psia

Run Number	19252	19253	19254	19255	19257	19256	19258	19259
Run Type	TR	TR	TR	TR	TR	TR	TR	TR
Column Top Pressure, psia	99.8	99.9	100.1	99.8	100.6	99.7	100.1	100.0
Reboiler Duty, M Btu/h	2.11	2.11	4.14	4.14	6.21	6.22	8.27	8.27
Condenser Duty, M Btu/h	2.16	2.18	3.92	3.94	5.57	5.54	8.42	8.41
Heat Loss, M Btu/h	0.05	0.01	0.05	0.05	0.10	0.12	0.01	0.00
Reflux Flow Rate, k lb/h	13.60	13.48	32.11	31.72	45.39	45.64	55.23	55.01
Feed Rate, k lb/h	60.07	60.04	59.96	60.01	60.02	59.94	59.99	59.97
Feed Location	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom
Pressure Drops:								
Overall (144 inch), inch H ₂ O/ft	0.04	0.04	0.08	0.08	0.17	0.17	0.43	0.42
Top (73 inch), inch H ₂ O/ft	0.04	0.04	0.08	0.08	0.17	0.17	0.43	0.42
Bottom (77 inch), inch H ₂ O/ft	0.02	0.02	0.05	0.05	0.15	0.15	0.36	0.36
Liq. Dist., inch H ₂ O	0.11	0.11	0.23	0.22	0.40	0.38	0.80	0.80
Vap. Dist., inch H ₂ O	0.07	0.09	0.18	0.19	0.29	0.28	0.64	0.64
Head in Liq. Dist., inch Hot Liq.	0.89	0.88	1.48	1.46	4.18	4.14	8.44	8.42
Temperature Profile, (°F):								
Accumulator Tank	78.1	76.8	120.9	120.1	112.6	113.9	85.0	84.5
Reflux	81.0	79.4	120.4	119.6	112.2	113.8	84.9	84.2
Overhead Vapor	130.9	130.0	129.1	128.9	132.0	131.4	128.6	128.0
Liq. Dist.	128.1	128.5	127.3	127.1	127.1	127.0	118.6	118.5
142.75 inches*	129.3	128.5	128.0	127.9	131.1	130.7	128.7	128.2
130.75 inches	128.9	128.0	130.0	129.9	132.0	132.0	130.2	129.7
106.75 inches	130.7	129.9	133.7	133.6	135.1	135.2	133.3	132.7
82.75 inches	131.1	130.3	135.3	135.2	137.3	136.8	135.2	134.7
58.75 inches	133.3	133.5	139.1	138.9	140.5	139.8	140.6	140.9
34.75 inches	136.0	135.1	137.7	137.5	138.5	138.7	137.2	137.0
10.75 inches	137.9	137.1	139.4	139.0	140.0	139.7	138.9	138.7
-10.00 inches	140.9	141.0	143.0	143.0	143.7	143.0	143.8	143.8
Vap. Dist./Liq. Collector	139.4	138.4	140.9	140.6	141.6	141.7	139.7	139.0
Reboiler Vapor	144.2	143.2	145.5	145.2	146.6	146.6	144.4	143.9
Bottoms from Reboiler	143.3	142.2	144.6	144.3	145.6	145.4	143.6	143.1
Feed	142.0	141.9	143.3	143.0	143.0	142.2	143.3	143.1
Liquid to Reboiler	143.1	142.2	144.1	143.8	144.6	144.7	142.6	142.1
Composition of Liquid, (mol %iC₄):								
Reflux	47.40	47.25	58.08	57.62	52.57	52.77	51.69	51.73
Liq. Dist.	46.54	46.55	57.61	57.23	52.35	52.37	51.51	51.54
Mid Point 72 inches*	32.68	32.23	33.81	33.58	30.16	29.58	26.61	26.58
13.25 inches	23.74	23.43	20.88	19.97	18.15	18.02	13.72	13.78
-8.00 inches	20.00	20.04	15.97	15.52	14.92	14.70	12.13	12.39
-12.00 inches	20.16	20.25	16.08	15.59	14.74	14.66	12.22	12.29
Vap. Dist./Liq. Collector	20.23	21.16	15.45	14.18	13.88	14.39	11.83	11.90
Downcomer	19.48	19.71	16.18	15.18	14.86	14.78	12.97	12.72
Bottom	16.09	16.18	12.32	12.02	11.82	11.84	10.18	10.01
Feed	16.28	16.27	12.30	11.98	11.85	11.86	10.11	10.09
Conditions @ 72 inch Based on Reboiler Duty:								
Temperature, °F	132.0	131.9	137.6	137.5	139.4	138.7	138.7	138.7
Vapor Density, lb/ft ³	0.987	0.984	1.069	1.066	1.079	1.067	1.058	1.058
Liquid Density, lb/ft ³	33.05	33.07	32.77	32.78	32.76	32.80	32.85	32.85
Vapor Flow Rate, k lb/h	15.20	15.46	30.60	30.59	45.74	45.50	61.44	61.53
Liquid Flow Rate, gpm	57.69	58.66	117.19	117.09	175.26	174.10	234.72	235.05
F _s , ft/s(lb/ft ³) ^{0.5}	0.346	0.346	0.662	0.662	0.989	0.992	1.322	1.322
Capacity Factor, C _s , ft/s	0.061	0.061	0.118	0.118	0.176	0.176	0.234	0.234
Pressure Drop, inch H ₂ O/ft	0.04	0.04	0.08	0.08	0.17	0.17	0.43	0.42
HETP (Dist. & Below Bed), inches	29.0	29.2	18.4	18.2	19.6	19.6	18.0	18.1
HETP (Dist. & DC), inches	28.2	28.7	18.5	18.0	19.7	19.6	18.7	18.5
Relative Volatility	1.302	1.303	1.295	1.296	1.294	1.295	1.297	1.297

* Elevation Above Support Plate

Table III (English Units) (Cont'd)
 F.R.I. 4 foot Diameter High Pressure Column
 Raschig-Super Ring No. 2, 12 Foot Packing Depth, F.R.I. TDP Distributor (10 mm Tubes)
 Isobutane/Normal Butane System, 100 psia

Run Number	19260	19261	19265	19264	19262	19263	19250	19251
Run Type	TR	TR	TR	TR	TR	TR	FT	FT
Column Top Pressure, psia	100.0	100.3	101.0	100.7	100.9	99.9	100.2	100.3
Reboiler Duty, M Btu/h	9.28	9.29	9.54	9.54	9.81	9.81	10.34	10.34
Condenser Duty, M Btu/h	8.57	8.54	9.41	8.95	9.52	9.56	9.26	9.14
Heat Loss, M Btu/h			0.07	0.04	0.06	0.05	0.08	0.03
Reflux Flow Rate, k lb/h	69.63	68.54	64.47	65.92	71.70	71.26	77.23	75.24
Feed Rate, k lb/h	59.99	60.09	60.02	60.04	59.94	59.93	60.03	60.01
Feed Location	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom
Pressure Drops:								
Overall (144 inch), inch H ₂ O/ft	0.73	0.70	0.88	0.91	0.94	0.94	1.02	0.96
Top (73 inch), inch H ₂ O/ft	0.76	0.73	0.98	1.04	1.19	1.19	1.29	1.16
Bottom (77 inch), inch H ₂ O/ft	0.66	0.65	0.72	0.73	0.69	0.69	0.70	0.71
Liq. Dist., inch H ₂ O	0.81	0.79	0.94	0.95	1.46	1.48	1.77	1.58
Vap. Dist., inch H ₂ O	0.77	0.74	0.85	0.85	0.77	0.78	0.84	0.85
Head in Liq. Dist., inch Hot Liq.	11.58	11.29	11.68	12.11	15.78	15.94	19.81	17.37
Temperature Profile, (°F):								
Accumulator Tank	119.7	117.1	97.3	103.5	118.4	117.2	125.8	121.9
Reflux	119.0	116.3	96.4	102.3	118.1	117.1	124.7	121.0
Overhead Vapor	132.1	131.9	133.3	133.5	138.1	137.3	136.0	134.8
Liq. Dist.	131.6	131.2	128.9	131.0	131.1	131.0	130.6	128.7
142.75 inches*	132.5	132.1	133.7	133.9	137.8	137.0	136.7	134.2
130.75 inches	134.0	133.7	134.9	134.8	139.5	138.8	138.8	136.5
106.75 inches	136.1	135.8	137.2	137.5	140.7	139.9	138.3	137.2
82.75 inches	138.5	138.1	138.8	138.9	140.9	140.2	138.5	137.1
58.75 inches	143.6	143.7	143.9	144.1	144.5	143.7	141.8	141.9
34.75 inches	139.6	139.3	140.1	140.4	141.6	140.6	139.4	137.8
10.75 inches	141.1	140.6	141.2	141.2	142.4	141.8	140.8	138.9
-10.00 inches	145.8	145.8	146.8	146.9	145.7	145.1	143.4	143.5
Vap. Dist./Liq. Collector	141.4	140.9	141.1	141.3	141.9	141.1	139.1	138.8
Reboiler Vapor	146.5	146.1	146.9	147.2	147.5	146.4	145.0	144.3
Bottoms from Reboiler	145.8	145.1	145.6	145.9	146.8	146.2	144.1	143.3
Feed	146.3	145.8	143.6	144.7	145.2	144.9	142.0	142.5
Liquid to Reboiler	144.5	144.1	144.4	144.6	145.2	144.3	142.6	141.8
Composition of Liquid, (mol %iC₄):								
Reflux	42.99	42.97	36.23	35.65	28.64	27.80	30.94	31.22
Distributor	42.52	42.49	35.52	35.10	27.64	27.03	30.22	30.35
Mid Point 72 inches*	19.21	18.95	14.57	14.18	17.34	16.93	23.35	23.50
13.25 inches	9.25	9.29	8.49	7.85	14.32	13.72	19.39	18.53
-8.00 inches	8.64	8.42	8.25	7.66	14.40	14.00	18.51	18.09
-12.00 inches	8.56	8.59	8.32	7.55	14.23	13.93	19.24	18.18
Vap. Dist./Liq. Collector	8.71	8.63	8.68	7.65	15.02	15.10	19.72	19.09
Downcomer	8.95	9.71	9.56	8.74	17.19	18.27	21.25	22.98
Bottom	7.40	7.50	7.46	6.74	12.84	12.91	17.01	16.69
Feed	7.42	7.39	7.62	6.72	12.80	12.77	16.96	16.46
Conditions @ 72 inch Based on Reboiler Duty:								
Temperature, °F	141.9	141.8	142.2	142.3	143.3	142.6	140.7	140.4
Vapor Density, lb/ft ³	1.081	1.079	1.071	1.070	1.096	1.084	1.076	1.071
Liquid Density, lb/ft ³	32.83	32.84	32.90	32.90	32.80	32.84	32.82	32.83
Vapor Flow Rate, k lb/h	69.11	69.16	70.03	70.19	72.52	72.47	76.42	76.72
Liquid Flow Rate, gpm	264.20	264.33	267.14	267.73	277.51	276.96	292.29	293.32
F _s , ft/s(lb/ft ³) ^{0.5}	1.466	1.467	1.506	1.508	1.540	1.546	1.641	1.643
Capacity Factor, C _s , ft/s	0.260	0.260	0.267	0.267	0.273	0.274	0.291	0.292
Pressure Drop, inch H ₂ O/ft	0.73	0.70	0.88	0.91	0.94	0.94	1.02	0.96
HETP (Dist. & Below Bed), inches	17.8	17.8	20.4	19.6	43.9	44.2	58.3	54.0
HETP (Dist. & DC), inches	18.2	19.1	22.3	21.3	59.9	71.8	76.1	95.8
Relative Volatility	1.293	1.294	1.293	1.293	1.290	1.292	1.293	1.295

* Elevation Above Support Plate

Table I (SI Units)
 F.R.I. 1.22 Meter Diameter High Pressure Column
 Raschig-Super Ring No. 2, 3.66 Meter Packing Depth, F.R.I. TDP Distributor (6.5 mm Tubes)
 Cyclohexane/n-Heptane System, 1.65 bar

Run Number	19214	19215	19217	19216	19213	19212	19219	19218	19220	19221
Run Type	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR
Column Top Pressure, bar	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65
Reboiler Duty, MW	0.50	0.50	0.99	0.99	1.24	1.24	1.49	1.49	1.82	1.82
Condenser Duty, MW	0.43	0.45	0.92	0.94	1.16	1.16	1.41	1.44	1.73	1.73
Heat Loss, MW	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.04	0.04	0.05
Reflux Flow Rate, kg/s	0.95	0.97	2.17	2.17	2.69	2.70	3.39	3.41	4.15	4.15
Feed Rate, kg/s	7.56	7.56	7.56	7.56	7.56	7.55	7.56	7.56	7.56	7.55
Feed Location	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom
Pressure Drops:										
Overall (3.66 m), mbar/m	0.08	0.08	0.48	0.46	0.82	0.83	1.43	1.44	2.99	2.99
Top (1.85 m), mbar/m	0.06	0.06	0.47	0.45	0.76	0.76	1.30	1.31	2.57	2.57
Bottom (1.96 m), mbar/m	0.07	0.09	0.59	0.64	0.73	0.73	1.31	1.33	3.11	3.11
Liq. Dist., mbar			0.39	0.36	0.83	0.83	1.54	1.54	1.99	1.99
Vap. Dist., mbar			0.34	0.32	0.72	0.72	1.19	1.22	2.07	2.07
Head in Liq. Dist., mm Hot Liq.	14.8	15.2	67.3	65.8	129.5	130.0	221.1	222.5	327.3	328.1
Temperature Profile, (°C):										
Accumulator Tank	33.3	33.4	37.8	38.3	39.2	39.0	41.7	42.4	43.2	42.8
Reflux	37.2	36.9	40.2	40.8	40.1	40.1	43.4	43.6	43.8	43.4
Overhead Vapor	102.4	102.4	102.3	102.3	102.3	102.3	102.5	102.5	101.9	101.8
Liq. Dist.	98.1	97.9	96.5	96.9	98.0	97.8	97.4	97.4	94.4	94.4
3.63 m*	101.6	101.6	101.6	101.8	101.8	101.9	102.2	102.2	101.6	101.6
3.32 m	103.9	103.3	101.5	101.7	101.7	101.6	102.4	102.4	102.2	102.2
2.71 m	106.4	106.3	103.5	103.7	103.9	103.8	104.5	104.5	104.2	104.4
2.10 m	107.8	108.8	105.1	105.4	105.7	106.0	106.3	106.3	106.7	106.8
1.49 m	111.1	110.2	107.1	107.1	108.0	108.4	108.5	108.7	109.6	109.0
0.88 m	110.6	110.4	109.6	109.8	109.8	110.1	110.1	110.3	110.3	110.5
0.27 m	111.9	111.8	111.6	111.4	111.5	111.2	111.4	111.6	112.1	112.1
-0.25 m	112.3	112.4	112.1	112.1	112.3	112.3	112.4	112.4	113.1	113.1
Vap. Dist./Liq. Collector	110.9	110.9	112.1	112.1	111.8	111.8	112.1	112.1	112.4	112.3
Reboiler Vapor	113.6	113.6	113.8	113.8	113.6	113.6	113.9	113.9	114.2	114.1
Bottoms from Reboiler	113.5	113.4	113.9	113.9	113.7	113.8	114.3	114.2	114.5	114.6
Feed	111.3	111.3	111.9	112.1	111.5	111.4	112.0	112.1	112.3	112.2
Liquid to Reboiler	113.2	113.2	113.7	113.7	113.3	113.3	113.8	113.8	114.1	114.1
Composition of Liquid, (mol% C₆):										
Reflux	76.66	76.37	77.50	77.52	74.87	75.41	75.23	75.17	75.25	75.04
Liq. Dist.	75.53	75.02	76.44	76.64	75.24	74.24	73.59	73.95	74.13	74.10
Mid Point 1.83 m*	43.32	40.11	49.01	48.00	51.08	43.22	45.14	43.84	40.05	41.07
0.34 m	17.67	18.76	22.38	22.79	22.11	20.60	23.13	21.19	17.14	16.59
-0.20 m	14.84	14.29	17.07	16.65	16.35	15.71	16.43	15.83	12.72	12.41
-0.30 m	14.17	16.01	17.59	16.73	16.27	17.30	17.03	17.37	13.41	12.96
Vap. Dist./Liq. Collector	16.36	14.21	16.00	15.38	14.35	15.33	14.88	14.81	11.93	11.88
Downcomer	13.06	13.47	15.04	14.33	12.82	14.09	13.96	13.98	12.24	12.31
Bottom	9.99	10.01	9.96	9.86	9.69	9.43	10.17	10.08	8.54	8.61
Feed	10.32	10.33	10.09	10.03	9.82	9.86	10.23	10.15	8.75	8.72
Conditions @ 1.83 m Based on Reboiler Duty:										
Temperature, °C	109.7	109.6	105.9	106.1	106.8	107.2	107.4	107.4	108.2	107.9
Vapor Density, kg/m ³	5.52	5.45	5.11	5.12	5.26	5.18	5.24	5.23	5.27	5.28
Liquid Density, kg/m ³	632.94	630.41	641.80	640.75	642.67	635.52	636.92	635.75	631.75	606.41
Vapor Flow Rate, kg/s	1.41	1.42	2.93	2.95	3.69	3.71	4.49	4.51	5.54	5.71
Liquid Flow Rate, m ³ /h	8.02	8.13	16.41	16.55	20.66	21.01	25.38	25.52	31.59	33.91
F _S , m/s(kg/m ³) ^{0.5}	0.519	0.528	1.120	1.127	1.391	1.410	1.697	1.705	2.090	2.152
Capacity Factor, C _s , m/s	0.021	0.021	0.044	0.045	0.055	0.056	0.068	0.068	0.083	0.088
Pressure Drop, mbar/m	0.08	0.08	0.48	0.46	0.82	0.83	1.43	1.44	2.99	2.99
HETP (Dist. & Below Bed), m	0.56	0.58	0.60	0.58	0.59	0.61	0.62	0.61	0.55	0.55
HETP (Dist. & DC), m	0.54	0.55	0.56	0.55	0.54	0.57	0.57	0.57	0.54	0.54
Relative Volatility	1.558	1.559	1.563	1.563	1.560	1.564	1.561	1.562	1.562	1.563

* Elevation Above Support Plate

Table I (SI Units) (Cont'd)
 F.R.I. 1.22 Meter Diameter High Pressure Column
 Raschig-Super Ring No. 2, 3.66 Meter Packing Depth, F.R.I. TDP Distributor (6.5 mm Tubes)
 Cyclohexane/n-Heptane System, 1.65 bar

Run Number	19223	19222	19224	19225	19227	19226	19228	19229	19209	19208
Run Type	TR	TR	TR	TR	TR	TR	FT	FT	FT	FT
Column Top Pressure, bar	1.65	1.65	1.65	1.65	1.65	1.65	1.66	1.66	1.66	1.66
Reboiler Duty, MW	1.98	1.98	2.06	2.07	2.24	2.24	2.48	2.48	2.49	2.49
Condenser Duty, MW	1.87	1.88	1.99	2.00	2.22	2.21	2.40	2.40	2.41	2.41
Heat Loss, MW	0.06	0.06	0.06	0.06	0.04	0.03	0.05	0.05	0.03	0.03
Reflux Flow Rate, kg/s	4.44	4.45	4.97	4.75	5.59	5.57	5.88	5.85	5.95	5.97
Feed Rate, kg/s	7.56	7.56	7.56	7.56	7.56	7.56	7.55	7.56	5.29	5.29
Feed Location	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom
Pressure Drops:										
Overall (3.66 m), mbar/m	4.64	4.62	8.51	8.57	12.90	11.22	15.79	15.58	14.68	14.66
Top (1.85 m), mbar/m	3.65	3.64	10.48	10.53	16.64	14.73	18.16	18.17	18.28	18.07
Bottom (1.96 m), mbar/m	5.18	5.19	6.10	6.15	8.35	7.44	12.32	11.92	10.16	10.00
Liq. Dist., mbar	6.82	6.81	4.91	4.98	9.11	8.52	12.06	11.71	11.59	11.64
Vap. Dist., mbar	7.11	7.02	2.24	2.26	2.61	2.67	9.63	9.25	5.70	5.80
Head in Liq. Dist., mm Hot Liq.	360.6	360.6	544.0	530.3	779.3	780.8	804.3	803.5	802.8	805.7
Temperature Profile, (°C):										
Accumulator Tank	41.7	42.6	45.2	45.4	54.4	53.6	45.6	45.1	46.8	46.3
Reflux	42.0	43.1	45.4	45.6	54.8	52.6	46.1	45.6	47.2	46.7
Overhead Vapor	101.5	101.6	104.9	104.8	105.7	105.3	106.2	106.3	105.8	105.8
Liq. Dist.	90.6	90.8	75.1	75.1	79.1	78.5	73.3	73.4	73.3	73.2
3.63 m*	101.2	101.3	104.7	104.7	107.9	105.9	107.4	107.4	107.5	107.5
3.32 m	102.2	102.3	106.1	106.3	107.0	105.9	107.4	107.4	107.2	107.1
2.71 m	104.4	104.4	107.8	107.8	106.8	106.0	107.6	107.6	107.3	107.2
2.10 m	107.5	107.5	108.7	108.8	107.1	105.9	107.6	107.6	107.3	107.2
1.49 m	109.9	110.1	110.9	110.9	108.8	107.1	108.0	107.9	108.2	108.1
0.88 m	111.4	111.5	110.2	110.3	110.0	109.8	109.2	109.3	109.7	109.7
0.27 m	112.6	112.7	110.9	110.9	110.2	110.2	109.6	109.7	109.8	109.3
-0.25 m	113.6	113.5	112.2	112.3	110.8	110.3	109.8	110.1	110.7	110.6
Vap. Dist./Liq. Collector	112.9	113.0	111.6	111.6	108.7	108.6	110.6	110.6	109.1	109.1
Reboiler Vapor	114.6	114.7	113.2	113.2	111.7	111.6	113.2	113.3	111.8	111.8
Bottoms from Reboiler	114.9	115.0	113.6	113.7	112.2	112.1	113.8	113.8	112.3	112.2
Feed	111.9	111.9	110.7	110.8	110.4	110.3	111.4	111.3	109.9	110.0
Liquid to Reboiler	114.3	114.4	112.8	112.8	111.4	111.3	112.8	112.9	111.3	111.4
Composition of Liquid, (mol% C₆):										
Reflux	76.62	76.51	58.47	57.99	50.78	52.27	49.73	49.84	48.81	48.86
Liq. Dist.	75.34	75.53	54.50	54.83	46.86	48.84	46.83	46.58	46.09	46.44
Mid Point 1.83 m*	41.70	38.37	33.27	32.60	49.45	45.50	47.05	45.86	41.97	41.94
0.34 m	11.45	11.77	20.76	20.27	31.47	32.64	39.04	39.97	39.68	38.70
-0.20 m	11.14	11.42	21.45	20.77	28.99	29.49	37.77	35.24	30.67	30.46
-0.30 m	11.44	11.35	22.78	21.39	29.14	30.33	35.62	34.69	29.14	30.67
Vap. Dist./Liq. Collector	10.02	10.26	20.53	20.43	40.64	30.27	30.24	29.59	33.60	33.65
Downcomer	11.18	11.05	25.89	26.26	29.62	29.39	30.63	30.50	29.03	30.38
Bottom	7.53	7.52	16.53	16.68	26.23	25.05	29.00	27.06	27.01	26.79
Feed	7.69	7.62	16.77	16.59	25.50	25.21	25.24	25.12	27.37	27.25
Conditions @ 1.83 m Based on Reboiler Duty:										
Temperature, °C	108.7	108.8	110.0	110.1	107.9	106.3	107.7	107.6	107.6	107.6
Vapor Density, kg/m ³	5.35	5.31	5.39	5.38	5.38	5.10	5.31	5.29	5.22	5.21
Liquid Density, kg/m ³	632.67	629.81	624.39	623.81	640.06	638.37	638.23	637.26	634.02	634.04
Vapor Flow Rate, kg/s	5.99	5.99	6.33	6.34	6.82	6.82	7.55	7.57	7.66	7.66
Liquid Flow Rate, m ³ /h	34.07	34.26	36.48	36.59	38.35	38.48	42.59	42.73	43.49	43.49
F _S , m/s(kg/m ³) ^{0.5}	2.239	2.251	2.359	2.365	2.543	2.613	2.835	2.847	2.902	2.904
Capacity Factor, C _S , m/s	0.089	0.090	0.095	0.095	0.101	0.104	0.113	0.113	0.116	0.116
Pressure Drop, mbar/m	4.64	4.62	8.51	8.57	12.90	11.22	15.79	15.58	14.68	14.66
HETP (Dist. & Below Bed), m	0.51	0.51	1.13	1.08	2.11	2.03	3.92	3.36	2.34	2.40
HETP (Dist. & DC), m	0.51	0.51	1.32	1.33	2.19	1.97	2.35	2.36	2.20	2.37
Relative Volatility	1.561	1.562	1.562	1.562	1.558	1.562	1.558	1.558	1.559	1.560

* Elevation Above Support Plate

Table II (SI Units)
 F.R.I. 1.22 Meter Diameter High Pressure Column
 Raschig-Super Ring No. 2, 3.66 Meter Packing Depth, F.R.I. TDP Distributor (10 mm Tubes)
 Isobutane/Normal Butane System, 11.4 bar

Run Number	19233	19232	19242	19243	19235	19234	19236	19237	19239	19238
Run Type	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR
Column Top Pressure, bar	11.36	11.39	11.38	11.40	11.39	11.38	11.40	11.39	11.37	11.37
Reboiler Duty, MW	0.63	0.63	1.04	1.04	1.26	1.26	1.89	1.89	2.52	2.51
Condenser Duty, MW	0.66	0.68	1.01	1.02	1.22	1.32	1.81	1.85	2.41	2.48
Heat Loss, MW	0.02	0.03	0.07	0.06	0.05	0.03	0.02	0.01	0.06	0.05
Reflux Flow Rate, kg/s	1.81	1.81	2.75	2.80	3.67	3.77	5.61	5.58	7.64	7.65
Feed Rate, kg/s	7.56	7.57	7.56	7.56	7.57	7.56	7.56	7.55	7.52	8.02
Feed Location	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom
Pressure Drops:										
Overall (3.66 m), mbar/m	0.39	0.44	0.60	0.64	0.73	0.76	1.91	1.91	4.07	4.07
Top (1.85 m), mbar/m	0.32	0.33	0.55	0.59	0.79	0.77	1.89	1.88	4.14	4.13
Bottom (1.96 m), mbar/m	0.10	0.16	0.04	0.06	0.84	0.83	1.73	1.71	4.14	4.15
Liq. Dist., mbar	0.31	0.34	0.67	0.68	0.69	0.70	1.27	1.25	1.71	1.71
Vap. Dist., mbar	0.27	0.25	0.51	0.54	0.30	0.30	1.00	1.01	1.36	1.49
Head in Liq. Dist., mm Hot Liq.	23.4	23.9	41.4	43.5	55.8	58.9	171.4	170.8	299.6	299.4
Temperature Profile, (°C):										
Accumulator Tank	46.0	45.4	37.4	36.2	45.1	46.9	45.1	43.4	51.3	52.8
Reflux	45.9	45.4	36.5	35.3	45.1	46.6	44.8	43.3	51.0	52.7
Overhead Vapor	76.8	76.8	74.9	74.9	75.3	75.5	75.1	74.9	77.7	77.4
Liq. Dist.	75.3	75.0	71.6	71.5	71.1	71.2	70.2	70.3	70.4	70.3
3.63 m*	75.9	76.3	74.8	74.4	75.2	75.3	75.1	74.9	77.9	77.7
3.32 m	76.1	76.1	76.2	75.9	76.1	75.8	76.1	75.9	78.8	78.7
2.71 m	76.8	76.9	78.0	77.8	78.2	78.1	77.8	77.6	80.3	80.2
2.10 m	77.0	77.1	78.6	78.4	78.7	79.4	78.7	78.6	81.4	81.4
1.49 m	78.3	78.3	80.7	80.2	80.8	80.8	81.8	81.7	82.8	82.7
0.88 m	79.0	79.1	79.8	79.4	80.2	79.9	79.8	79.6	82.5	82.5
0.27 m	80.1	80.3	80.5	80.2	80.9	81.3	80.9	80.7	83.6	83.3
-0.25 m	82.2	81.1	82.9	83.0	83.4	83.4	83.9	83.9	84.7	84.4
Vap. Dist./Liq. Collector	81.2	81.2	81.3	81.2	82.0	82.1	81.4	81.2	83.7	83.7
Reboiler Vapor	84.9	84.5	84.6	84.7	85.8	85.6	85.3	85.1	87.8	87.2
Bottoms from Reboiler	83.9	83.9	84.4	84.2	85.4	84.9	84.8	84.8	87.3	86.8
Feed	82.6	82.7	81.3	81.4	82.9	83.4	84.0	84.1	84.7	84.7
Liquid to Reboiler	83.7	83.9	83.2	83.2	84.9	84.1	84.2	84.1	85.9	85.9
Composition of Liquid, (mol %iC₄):										
Reflux	47.76	47.54	56.05	55.91	58.08	57.48	54.09	54.01	51.20	49.11
Liq. Dist.	46.94	46.70	54.97	55.46	57.57	57.04	53.87	53.82	51.86	48.71
Mid Point 1.83 m*	35.81	33.13	32.34	34.06	37.06	37.37	33.44	33.09	30.52	28.58
0.34 m	31.12	31.68	24.31	25.31	26.25	25.85	22.38	22.96	16.03	14.84
-0.20 m	26.53	26.77	21.47	21.65	22.30	21.71	19.52	19.53	15.21	13.77
-0.30 m	27.57	27.38	22.57	21.46	22.14	21.77	19.85	19.87	15.94	14.17
Vap. Dist./Liq. Collector	25.28	25.35	20.30	20.72	20.93	20.94	19.53	19.31	14.48	13.56
Downcomer	26.40	26.13	21.16	21.41	21.75	21.40	20.17	20.03	15.22	14.03
Bottom	22.16	22.11	17.21	17.19	17.95	17.71	16.74	16.75	12.59	12.03
Feed	22.09	22.09	17.33	17.21	17.96	17.71	16.74	16.76	13.00	11.93
Conditions @ 1.83 m Based on Reboiler Duty:										
Temperature, °C	77.7	77.7	79.9	79.6	80.0	80.3	80.7	80.6	82.2	82.2
Vapor Density, kg/m ³	26.91	26.66	27.96	27.92	28.51	28.78	28.61	28.52	29.29	29.05
Liquid Density, kg/m ³	492.24	493.07	489.77	489.77	488.09	487.40	488.07	488.32	486.52	487.26
Vapor Flow Rate, kg/s	2.14	2.15	3.49	3.51	4.35	4.44	6.74	6.75	8.88	8.88
Liquid Flow Rate, m ³ /h	15.68	15.68	25.62	25.81	32.07	32.77	49.74	49.73	65.74	65.58
F _s , m/s(kg/m ³) ^{0.5}	0.358	0.360	0.570	0.575	0.705	0.716	1.091	1.093	1.420	1.425
Capacity Factor, C _s , m/s	0.017	0.017	0.027	0.027	0.033	0.033	0.051	0.051	0.066	0.067
Pressure Drop, mbar/m	0.39	0.44	0.60	0.64	0.73	0.76	1.91	1.91	4.07	4.07
HETP (Dist. & Below Bed), m	0.83	0.85	0.50	0.49	0.47	0.46	0.47	0.47	0.42	0.42
HETP (Dist. & DC), m	0.81	0.80	0.49	0.49	0.46	0.46	0.48	0.48	0.41	0.42
Relative Volatility	1.237	1.237	1.235	1.235	1.233	1.232	1.233	1.234	1.229	1.230

* Elevation Above Support Plate

Table II (SI Units) (Cont'd)
 F.R.I. 1.22 Meter Diameter High Pressure Column
 Raschig-Super Ring No. 2, 3.66 Meter Packing Depth, F.R.I. TDP Distributor (10 mm Tubes)
 Isobutane/Normal Butane System, 11.4 bar

Run Number	19245	19244	19246	19247	19266	19267	19249	19248	19231	19230
Run Type	TR	TR	TR	TR	TR	TR	TR	TR	FT	FT
Column Top Pressure, bar	11.40	11.40	11.40	11.41	11.40	11.41	11.41	11.39	11.42	11.38
Reboiler Duty, MW	2.64	2.64	2.80	2.80	2.84	2.84	2.97	2.97	3.15	3.16
Condenser Duty, MW	2.64	2.68	2.68	2.62	2.45	2.88	3.06	3.02	3.04	3.05
Heat Loss, MW	0.04	0.02	0.06	0.04	0.03	0.01	0.01	0.01	0.02	0.02
Reflux Flow Rate, kg/s	8.67	8.71	8.77	8.75	7.81	7.66	9.98	9.88	10.08	10.09
Feed Rate, kg/s	7.56	7.55	7.57	7.56	7.56	7.54	7.56	7.56	7.56	7.55
Feed Location	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom
Pressure Drops:										
Overall (3.66 m), mbar/m	4.98	5.26	6.92	6.85	7.40	7.50	6.93	6.96	8.54	8.49
Top (1.85 m), mbar/m	5.24	5.49	7.79	7.53	9.49	9.62	8.45	8.44	10.92	10.84
Bottom (1.96 m), mbar/m	4.29	4.54	5.53	5.62	5.19	5.32	4.93	5.00	6.14	6.12
Liq. Dist., mbar	1.86	1.96	2.22	2.21	2.90	2.85	3.53	3.57	4.80	4.74
Vap. Dist., mbar	1.32	1.42	1.74	1.76	1.62	1.58	1.75	1.76	1.77	1.76
Head in Liq. Dist., mm Hot Liq.	353.0	358.8	378.7	377.3	356.5	349.5	480.5	466.2	573.3	572.9
Temperature Profile, (°C):										
Accumulator Tank	61.8	61.2	56.9	57.2	38.8	36.3	67.3	65.4	57.9	58.4
Reflux	61.0	60.6	55.9	56.7	38.9	36.4	66.6	64.9	57.8	58.4
Overhead Vapor	76.1	76.2	78.3	78.3	78.9	78.4	79.0	78.9	78.4	78.3
Liq. Dist.	72.6	72.4	71.3	71.6	67.4	67.3	71.4	70.2	65.9	66.1
3.63 m*	76.3	76.5	78.5	78.5	79.1	78.7	78.7	78.6	78.3	78.0
3.32 m	77.4	77.5	79.4	79.4	80.5	80.2	80.2	80.1	79.6	79.3
2.71 m	78.4	78.6	81.1	80.6	81.4	80.9	81.1	81.2	79.3	79.1
2.10 m	80.2	80.4	82.1	82.0	82.1	81.5	81.3	81.3	79.8	79.7
1.49 m	83.0	83.1	83.6	83.5	84.2	84.2	83.2	83.2	82.6	82.2
0.88 m	80.8	80.9	82.9	82.4	82.0	82.6	81.5	81.4	80.7	80.6
0.27 m	81.4	81.8	83.6	83.2	83.6	82.9	82.4	82.1	81.0	81.1
-0.25 m	85.3	85.4	85.1	84.8	85.0	85.8	85.4	84.8	83.3	83.2
Vap. Dist./Liq. Collector	82.6	82.6	83.2	83.2	81.9	82.4	81.5	81.4	80.2	80.0
Reboiler Vapor	85.6	85.7	87.2	86.8	85.9	85.8	84.6	84.7	84.2	84.0
Bottoms from Reboiler	85.3	85.4	86.9	86.6	85.6	85.3	84.4	84.4	83.9	83.9
Feed	83.6	84.4	84.4	84.6	84.3	84.9	83.8	83.8	83.1	82.9
Liquid to Reboiler	84.3	84.4	85.9	85.5	84.7	84.5	83.4	83.4	82.3	82.1
Composition of Liquid, (mol %iC₄):										
Reflux	50.66	49.99	43.21	43.62	29.21	31.78	31.98	32.06	36.46	36.63
Liq. Dist.	49.93	49.72	43.25	43.36	29.25	30.89	31.59	31.61	35.87	35.95
Mid Point 1.83 m*	27.41	27.30	20.21	20.91	16.89	16.54	24.37	25.12	31.11	31.73
0.34 m	15.38	15.43	14.28	14.36	14.60	15.29	22.04	21.79	28.22	27.45
-0.20 m	14.93	15.17	14.20	14.31	14.47	14.47	21.87	21.77	27.78	27.24
-0.30 m	15.64	15.90	13.93	14.09	15.12	13.95	21.66	21.77	27.73	27.61
Vap. Dist./Liq. Collector	15.34	15.20	14.43	14.60	15.26	14.44	22.87	22.60	26.65	28.77
Downcomer	15.93	15.85	15.32	15.29	18.38	14.85	24.67	24.88	30.23	30.60
Bottom	13.04	12.98	12.83	12.71	13.41	12.44	19.75	19.98	25.23	25.35
Feed	13.19	13.04	12.78	12.92	13.62	12.98	19.80	19.87	25.37	25.29
Conditions @ 1.83 m Based on Reboiler Duty:										
Temperature, °C	82.1	82.2	83.0	83.0	83.5	83.2	82.6	82.6	81.6	81.3
Vapor Density, kg/m ³	28.86	28.91	28.71	28.77	28.71	28.48	28.88	28.97	28.93	28.83
Liquid Density, kg/m ³	487.82	487.70	488.73	488.50	488.98	489.60	487.97	487.70	487.39	487.62
Vapor Flow Rate, kg/s	9.35	9.41	9.82	9.87	10.04	10.09	10.62	10.63	11.29	11.29
Liquid Flow Rate, m ³ /h	68.97	69.42	72.33	72.75	73.91	74.17	78.34	78.49	83.37	83.31
F _S , m/s(kg/m ³) ^{0.5}	1.505	1.514	1.586	1.593	1.622	1.636	1.710	1.710	1.816	1.819
Capacity Factor, C _s m/s	0.070	0.071	0.074	0.074	0.076	0.076	0.080	0.080	0.085	0.085
Pressure Drop, mbar/m	4.98	5.26	6.92	6.85	7.40	7.50	6.93	6.96	8.54	8.49
HETP (Dist. & Below Bed), m	0.44	0.45	0.49	0.49	0.85	0.75	1.43	1.43	1.85	1.76
HETP (Dist. & DC), m	0.45	0.45	0.52	0.52	1.20	0.79	2.07	2.15	2.65	2.79
Relative Volatility	1.233	1.232	1.230	1.231	1.230	1.231	1.231	1.231	1.231	1.232

* Elevation Above Support Plate

Table III (SI Units)
 F.R.I. 1.22 Meter Diameter High Pressure Column
 Raschig-Super Ring No. 2, 3.66 Meter Packing Depth, F.R.I. TDP Distributor (10 mm Tubes)
 Isobutane/Normal Butane System, 6.89 bar

Run Number	19252	19253	19254	19255	19257	19256	19258	19259
Run Type	TR	TR	TR	TR	TR	TR	TR	TR
Column Top Pressure, bar	6.88	6.89	6.90	6.88	6.94	6.88	6.90	6.89
Reboiler Duty, MW	0.62	0.62	1.21	1.21	1.82	1.82	2.42	2.42
Condenser Duty, MW	0.63	0.64	1.15	1.15	1.63	1.62	2.46	2.46
Heat Loss, MW	0.01	0.00	0.01	0.01	0.03	0.03	0.00	0.00
Reflux Flow Rate, kg/s	1.71	1.70	4.05	4.00	5.72	5.75	6.96	6.93
Feed Rate, kg/s	7.57	7.57	7.55	7.56	7.56	7.55	7.56	7.56
Feed Location	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom
Pressure Drops:								
Overall (3.66 m), mbar/m	0.35	0.36	0.65	0.65	1.36	1.36	3.48	3.45
Top (1.85 m), mbar/m	0.32	0.33	0.64	0.63	1.38	1.37	3.48	3.46
Bottom (1.96 m), mbar/m	0.20	0.17	0.42	0.43	1.22	1.24	2.97	2.94
Liq. Dist., mbar	0.27	0.26	0.57	0.56	0.98	0.95	1.98	1.98
Vap. Dist., mbar	0.18	0.22	0.46	0.47	0.73	0.70	1.60	1.59
Head in Liq. Dist., mm Hot Liq.	22.5	22.3	37.5	37.1	106.1	105.0	214.3	213.8
Temperature Profile, (°C):								
Accumulator Tank	25.6	24.9	49.4	48.9	44.8	45.5	29.4	29.2
Reflux	27.2	26.3	49.1	48.7	44.6	45.4	29.4	29.0
Overhead Vapor	54.9	54.4	53.9	53.8	55.6	55.2	53.7	53.3
Liq. Dist.	53.4	53.6	52.9	52.8	52.8	52.8	48.1	48.1
3.63 m*	54.1	53.6	53.3	53.3	55.1	54.8	53.7	53.4
3.32 m	53.8	53.3	54.4	54.4	55.6	55.6	54.6	54.3
2.71 m	54.8	54.4	56.5	56.4	57.3	57.3	56.3	55.9
2.10 m	55.1	54.6	57.4	57.3	58.5	58.2	57.3	57.1
1.49 m	56.3	56.4	59.5	59.4	60.3	59.9	60.3	60.5
0.88 m	57.8	57.3	58.7	58.6	59.2	59.3	58.4	58.3
0.27 m	58.8	58.4	59.7	59.4	60.0	59.8	59.4	59.3
-0.25 m	60.5	60.6	61.7	61.7	62.1	61.7	62.1	62.1
Vap. Dist./Liq. Collector	59.7	59.1	60.5	60.3	60.9	60.9	59.8	59.4
Reboiler Vapor	62.3	61.8	63.1	62.9	63.7	63.7	62.4	62.2
Bottoms from Reboiler	61.8	61.2	62.6	62.4	63.1	63.0	62.0	61.7
Feed	61.1	61.1	61.8	61.7	61.7	61.2	61.8	61.7
Liquid to Reboiler	61.7	61.2	62.3	62.1	62.6	62.6	61.4	61.2
Composition of Liquid, (mol %iC₄):								
Reflux	47.40	47.25	58.08	57.62	52.57	52.77	51.69	51.73
Liq. Dist.	46.54	46.55	57.61	57.23	52.35	52.37	51.51	51.54
Mid Point 1.83 m*	32.68	32.23	33.81	33.58	30.16	29.58	26.61	26.58
0.34 m	23.74	23.43	20.88	19.97	18.15	18.02	13.72	13.78
-0.20 m	20.00	20.04	15.97	15.52	14.92	14.70	12.13	12.39
-0.30 m	20.16	20.25	16.08	15.59	14.74	14.66	12.22	12.29
Vap. Dist./Liq. Collector	20.23	21.16	15.45	14.18	13.88	14.39	11.83	11.90
Downcomer	19.48	19.71	16.18	15.18	14.86	14.78	12.97	12.72
Bottom	16.09	16.18	12.32	12.02	11.82	11.84	10.18	10.01
Feed	16.28	16.27	12.30	11.98	11.85	11.86	10.11	10.09
Conditions @ 1.83 m Based on Reboiler Duty:								
Temperature, °C	55.6	55.5	58.7	58.6	59.7	59.3	59.3	59.3
Vapor Density, kg/m ³	15.81	15.77	17.13	17.08	17.28	17.09	16.95	16.95
Liquid Density, kg/m ³	529.49	529.68	524.96	525.14	524.70	525.41	526.21	526.21
Vapor Flow Rate, kg/s	1.92	1.95	3.86	3.85	5.76	5.73	7.74	7.75
Liquid Flow Rate, m ³ /h	13.10	13.32	26.62	26.59	39.81	39.54	53.31	53.39
F _s , m/s(kg/m ³) ^{0.5}	1.204	1.201	1.304	1.301	1.316	1.302	1.291	1.291
Capacity Factor, C _s , m/s	0.019	0.019	0.036	0.036	0.054	0.054	0.071	0.071
Pressure Drop, mbar/m	0.35	0.36	0.65	0.65	1.36	1.36	3.48	3.45
HETP (Dist. & Below Bed), m	0.74	0.74	0.47	0.46	0.50	0.50	0.46	0.46
HETP (Dist. & DC), m	0.72	0.73	0.47	0.46	0.50	0.50	0.47	0.47
Relative Volatility	1.302	1.303	1.295	1.296	1.294	1.295	1.297	1.297

* Elevation Above Support Plate

Table III (SI Units) (Cont'd)
 F.R.I. 1.22 Meter Diameter High Pressure Column
 Raschig-Super Ring No. 2, 3.66 Meter Packing Depth, F.R.I. TDP Distributor (10 mm Tubes)
Isobutane/Normal Butane System, 6.89 bar

Run Number	19260	19261	19265	19264	19262	19263	19250	19251
Run Type	TR	TR	TR	TR	TR	TR	FT	FT
Column Top Pressure, bar	6.90	6.91	6.96	6.94	6.95	6.89	6.91	6.92
Reboiler Duty, MW	2.72	2.72	2.80	2.79	2.87	2.87	3.03	3.03
Condenser Duty, MW	2.51	2.50	2.76	2.62	2.79	2.80	2.71	2.68
Heat Loss, MW			0.02	0.01	0.02	0.01	0.02	0.01
Reflux Flow Rate, kg/s	8.77	8.64	8.12	8.31	9.03	8.98	9.73	9.48
Feed Rate, kg/s	7.56	7.57	7.56	7.57	7.55	7.55	7.56	7.56
Feed Location	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom
Pressure Drops:								
Overall (3.66 m), mbar/m	5.95	5.74	7.20	7.46	7.65	7.68	8.34	7.83
Top (1.85 m), mbar/m	6.22	6.00	7.98	8.52	9.72	9.71	10.57	9.45
Bottom (1.96 m), mbar/m	5.39	5.34	5.87	5.92	5.68	5.65	5.71	5.84
Liq. Dist., mbar	2.02	1.97	2.35	2.35	3.63	3.68	4.41	3.93
Vap. Dist., mbar	1.93	1.85	2.12	2.11	1.91	1.94	2.08	2.12
Head in Liq. Dist., mm Hot Liq.	294.1	286.6	296.6	307.7	400.7	404.9	503.1	441.1
Temperature Profile, (°C):								
Accumulator Tank	48.7	47.3	36.3	39.7	48.0	47.3	52.1	49.9
Reflux	48.3	46.8	35.8	39.1	47.8	47.3	51.5	49.4
Overhead Vapor	55.6	55.5	56.3	56.4	58.9	58.5	57.8	57.1
Liq. Dist.	55.3	55.1	53.8	55.0	55.1	55.0	54.8	53.7
3.63 m*	55.8	55.6	56.5	56.6	58.8	58.3	58.2	56.8
3.32 m	56.7	56.5	57.2	57.1	59.7	59.3	59.3	58.1
2.71 m	57.8	57.7	58.4	58.6	60.4	59.9	59.1	58.4
2.10 m	59.2	58.9	59.3	59.4	60.5	60.1	59.2	58.4
1.49 m	62.0	62.1	62.2	62.3	62.5	62.1	61.0	61.1
0.88 m	59.8	59.6	60.1	60.2	60.9	60.3	59.7	58.8
0.27 m	60.6	60.3	60.7	60.7	61.3	61.0	60.4	59.4
-0.25 m	63.2	63.2	63.8	63.8	63.2	62.8	61.9	61.9
Vap. Dist./Liq. Collector	60.8	60.5	60.6	60.7	61.1	60.6	59.5	59.3
Reboiler Vapor	63.6	63.4	63.8	64.0	64.2	63.6	62.8	62.4
Bottoms from Reboiler	63.2	62.8	63.1	63.3	63.8	63.4	62.3	61.8
Feed	63.5	63.2	62.0	62.6	62.9	62.7	61.1	61.4
Liquid to Reboiler	62.5	62.3	62.4	62.6	62.9	62.4	61.4	61.0
Composition of Liquid, (mol %iC₄):								
Reflux	42.99	42.97	36.23	35.65	28.64	27.80	30.94	31.22
Liq. Dist.	42.52	42.49	35.52	35.10	27.64	27.03	30.22	30.35
Mid Point 1.83 m*	19.21	18.95	14.57	14.18	17.34	16.93	23.35	23.50
0.34 m	9.25	9.29	8.49	7.85	14.32	13.72	19.39	18.53
-0.20 m	8.64	8.42	8.25	7.66	14.40	14.00	18.51	18.09
-0.30 m	8.56	8.59	8.32	7.55	14.23	13.93	19.24	18.18
Vap. Dist./Liq. Collector	8.71	8.63	8.68	7.65	15.02	15.10	19.72	19.09
Downcomer	8.95	9.71	9.56	8.74	17.19	18.27	21.25	22.98
Bottom	7.40	7.50	7.46	6.74	12.84	12.91	17.01	16.69
Feed	7.42	7.39	7.62	6.72	12.80	12.77	16.96	16.46
Conditions @ 1.83 m Based on Reboiler Duty:								
Temperature, °C	61.1	61.0	61.2	61.3	61.8	61.4	60.4	60.2
Vapor Density, kg/m ³	17.32	17.29	17.15	17.14	17.56	17.36	17.23	17.16
Liquid Density, kg/m ³	525.90	526.03	527.03	527.03	525.34	526.04	525.67	525.89
Vapor Flow Rate, kg/s	8.71	8.71	8.82	8.84	9.14	9.13	9.63	9.67
Liquid Flow Rate, m ³ /h	60.01	60.04	60.67	60.81	63.03	62.90	66.39	66.62
F _s , m/s(kg/m ³) ^{0.5}	1.319	1.316	1.306	1.305	1.338	1.322	1.312	1.307
Capacity Factor, C _s , m/s	0.079	0.079	0.081	0.081	0.083	0.084	0.089	0.089
Pressure Drop, mbar/m	5.95	5.74	7.20	7.46	7.65	7.68	8.34	7.83
HETP (Dist. & Below Bed), m	0.45	0.45	0.52	0.50	1.12	1.12	1.48	1.37
HETP (Dist. & DC), m	0.46	0.49	0.57	0.54	1.52	1.82	1.93	2.43
Relative Volatility	1.293	1.294	1.293	1.293	1.290	1.292	1.293	1.295

* Elevation Above Support Plate

Table IV
 F.R.I. 4 Foot Diameter High Pressure Column
 Raschig-Super Ring No. 2, 12 Foot Packing Depth, F.R.I. TDP Distributor (10 mm Tubes)
Isobutane/Normal Butane System, 165 psia (11.4 bar)
 Liquid Composition, Mole Percent

Run Number	19230	19231	19232	19233	19234	19235	19236	19237	19238	19239
Composition of Liquid, (mol %iC₄):										
Reflux	36.63	36.46	47.54	47.76	57.48	58.08	54.09	54.01	49.11	51.20
Liq. Dist.	35.95	35.87	46.70	46.94	57.04	57.57	53.87	53.82	48.71	51.86
Mid Point 72 inches*	31.73	31.11	33.13	35.81	37.37	37.06	33.44	33.09	28.58	30.52
13.25 inches	27.45	28.22	31.68	31.12	25.85	26.25	22.38	22.96	14.84	16.03
-8.00 inches	27.24	27.78	26.77	26.53	21.71	22.30	19.52	19.53	13.77	15.21
-12.00 inches	27.61	27.73	27.38	27.57	21.77	22.14	19.85	19.87	14.17	15.94
Vap. Dist./Liq. Collector	28.77	26.65	25.35	25.28	20.94	20.93	19.53	19.31	13.56	14.48
Downcomer	30.60	30.23	26.13	26.40	21.40	21.75	20.17	20.03	14.03	15.22
Bottom	25.35	25.23	22.11	22.16	17.71	17.95	16.74	16.75	12.03	12.59
Feed	25.29	25.37	22.09	22.09	17.71	17.96	16.74	16.76	11.93	13.00
Composition of Liquid, (mol %C₃):										
Reflux	2.91	2.88	3.92	3.97	3.79	3.98	3.17	3.16	1.60	1.97
Liq. Dist.	2.70	2.66	3.18	3.27	3.36	3.45	2.92	2.93	1.49	2.13
Mid Point 72 inches*	0.66	0.71	0.09	0.38	0.09	0.09	0.07	0.07	0.03	0.05
13.25 inches	0.42	0.50	0.18	0.14	0.02	0.02	0.09	0.00	0.00	0.03
-8.00 inches	0.46	0.47	0.11	0.10	0.00	0.02	0.08	0.09	0.00	0.00
-12.00 inches	0.48	0.46	0.07	0.07	0.02	0.09	0.03	0.04	0.00	0.05
Vap. Dist./Liq. Collector	0.54	0.33	0.05	0.06	0.00	0.02	0.16	0.00	0.00	0.06
Downcomer	0.78	0.74	0.12	0.44	0.02	0.00	0.03	0.17	0.06	0.57
Bottom	0.47	0.47	0.02	0.02	0.16	0.00	0.00	0.00	0.00	0.13
Feed	0.29	0.29	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00

* Elevation Above Support Plate

Table IV (Cont'd)
 F.R.I. 4 Foot Diameter High Pressure Column
 Raschig-Super Ring No. 2, 12 Foot Packing Depth, F.R.I. TDP Distributor (10 mm Tubes)
Isobutane/Normal Butane System, 165 psia (11.4 bar)
 Liquid Composition, Mole Percent

Run Number	19242	19243	19244	19245	19246	19247	19248	19249	19266	19267
Composition of Liquid, (mol %iC₄):										
Reflux	56.05	55.91	49.99	50.66	43.21	43.62	32.06	31.98	29.21	31.78
Liq. Dist.	54.97	55.46	49.72	49.93	43.25	43.36	31.61	31.59	29.25	30.89
Mid Point 72 inches*	32.34	34.06	27.30	27.41	20.21	20.91	25.12	24.37	16.89	16.54
13.25 inches	24.31	25.31	15.43	15.38	14.28	14.36	21.79	22.04	14.60	15.29
-8.00 inches	21.47	21.65	15.17	14.93	14.20	14.31	21.77	21.87	14.47	14.47
-12.00 inches	22.57	21.46	15.90	15.64	13.93	14.09	21.77	21.66	15.12	13.95
Vap. Dist./Liq. Collector	20.30	20.72	15.20	15.34	14.43	14.60	22.60	22.87	15.26	14.44
Downcomer	21.16	21.41	15.85	15.93	15.32	15.29	24.88	24.67	18.38	14.85
Bottom	17.21	17.19	12.98	13.04	12.83	12.71	19.98	19.75	13.41	12.44
Feed	17.33	17.21	13.04	13.19	12.78	12.92	19.87	19.80	13.62	12.98
Composition of Liquid, (mol %C₃):										
Reflux	3.51	3.45	1.68	1.70	1.25	1.24	1.97	1.95	1.91	1.98
Liq. Dist.	2.95	3.03	1.57	1.56	1.17	1.19	1.85	1.86	1.79	1.80
Mid Point 72 inches*	0.06	0.07	0.03	0.02	0.04	0.00	0.34	0.27	0.08	0.09
13.25 inches	0.02	0.02	0.00	0.02	0.18	0.06	0.22	0.19	0.06	0.08
-8.00 inches	0.00	0.00	0.00	0.00	0.00	0.15	0.19	0.24	0.06	0.05
-12.00 inches	0.00	0.00	0.03	0.00	0.02	0.00	0.22	0.17	0.05	0.04
Vap. Dist./Liq. Collector	0.12	0.08	0.23	0.00	0.04	0.00	0.22	0.22	0.06	0.04
Downcomer	0.26	0.19	0.24	0.00	0.00	0.51	0.55	0.33	0.14	0.21
Bottom	0.17	0.03	0.00	0.00	0.19	0.09	0.12	0.29	0.06	0.00
Feed	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.12	0.04	0.02

* Elevation Above Support Plate

Table V
 F.R.I. 4 Foot Diameter High Pressure Column
 Raschig-Super Ring No. 2, 12 Foot Packing Depth, F.R.I. TDP Distributor (10 mm Tubes)
Isobutane/Normal Butane System, 100 psia (6.89 bar)
 Liquid Composition, Mole Percent

Run Number	19250	19251	19252	19253	19254	19255	19256	19257
Composition of Liquid, (mol %iC₄):								
Reflux	30.94	31.22	47.40	47.25	58.08	57.62	52.77	52.57
Liq. Dist.	30.22	30.35	46.54	46.55	57.61	57.23	52.37	52.35
Mid Point 72 inches*	23.35	23.50	32.68	32.23	33.81	33.58	29.58	30.16
13.25 inches	19.39	18.53	23.74	23.43	20.88	19.97	18.02	18.15
-8.00 inches	18.51	18.09	20.00	20.04	15.97	15.52	14.70	14.92
-12.00 inches	19.24	18.18	20.16	20.25	16.08	15.59	14.66	14.74
Vap. Dist./Liq. Collector	19.72	19.09	20.23	21.16	15.45	14.18	14.39	13.88
Downcomer	21.25	22.98	19.48	19.71	16.18	15.18	14.78	14.86
Bottom	17.01	16.69	16.09	16.18	12.32	12.02	11.84	11.82
Feed	16.96	16.46	16.28	16.27	12.30	11.98	11.86	11.85
Composition of Liquid, (mol %C₃):								
Reflux	1.11	1.00	3.94	3.84	3.09	2.92	2.33	2.28
Liq. Dist.	1.01	0.90	3.42	3.33	2.78	2.66	2.18	2.17
Mid Point 72 inches*	0.08	0.08	0.15	0.12	0.03	0.03	0.03	0.04
13.25 inches	0.05	0.04	0.02	0.02	0.04	0.00	0.00	0.00
-8.00 inches	0.04	0.05	0.00	0.00	0.00	0.00	0.00	0.00
-12.00 inches	0.05	0.04	0.00	0.00	0.00	0.06	0.00	0.00
Vap. Dist./Liq. Collector	0.07	0.05	0.03	0.01	0.00	0.00	0.00	0.03
Downcomer	0.16	0.24	0.00	0.15	0.00	0.13	0.00	0.07
Bottom	0.11	0.03	0.13	0.00	0.00	0.00	0.18	0.06
Feed	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00

* Elevation Above Support Plate

Table V (Cont'd)
 F.R.I. 4 Foot Diameter High Pressure Column
 Raschig-Super Ring No. 2, 12 Foot Packing Depth, F.R.I. TDP Distributor (10 mm Tubes)
Isobutane/Normal Butane System, 100 psia (6.89 bar)
 Liquid Composition, Mole Percent

Run Number	19258	19259	19260	19261	19262	19263	19264	19265
Composition of Liquid, (mol %iC₄):								
Reflux	51.69	51.73	42.99	42.97	28.64	27.80	35.65	36.23
Liq. Dist.	51.51	51.54	42.52	42.49	27.64	27.03	35.10	35.52
Mid Point 72 inches*	26.61	26.58	19.21	18.95	17.34	16.93	14.18	14.57
13.25 inches	13.72	13.78	9.25	9.29	14.32	13.72	7.85	8.49
-8.00 inches	12.13	12.39	8.64	8.42	14.40	14.00	7.66	8.25
-12.00 inches	12.22	12.29	8.56	8.59	14.23	13.93	7.55	8.32
Vap. Dist./Liq. Collector	11.83	11.90	8.71	8.63	15.02	15.10	7.65	8.68
Downcomer	12.97	12.72	8.95	9.71	17.19	18.27	8.74	9.56
Bottom	10.18	10.01	7.40	7.50	12.84	12.91	6.74	7.46
Feed	10.11	10.09	7.42	7.39	12.80	12.77	6.72	7.62
Composition of Liquid, (mol %C₃):								
Reflux	2.00	2.00	0.85	0.84	0.78	0.73	0.48	0.72
Liq. Dist.	1.92	1.90	0.78	0.78	0.68	0.64	0.44	0.66
Mid Point 72 inches*	0.02	0.02	0.00	0.02	0.03	0.02	0.00	0.02
13.25 inches	0.00	0.07	0.00	0.02	0.02	0.08	0.00	0.12
-8.00 inches	0.00	0.00	0.04	0.02	0.02	0.02	0.00	0.00
-12.00 inches	0.00	0.02	0.03	0.00	0.05	0.02	0.03	0.04
Vap. Dist./Liq. Collector	0.02	0.00	0.00	0.03	0.09	0.02	0.03	0.00
Downcomer	0.00	0.17	0.19	0.10	0.53	0.09	0.00	0.20
Bottom	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.00
Feed	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.02

* Elevation Above Support Plate

Table VI
 Process Density and Liquid Volume Fraction
 from Gamma Ray Scans
 Raschig-Super Ring No. 2, 12 ft (3.66 m) Packing Depth
 Cyclohexane/n-Heptane System, 24 psia (1.65 bar)

Run No.	Horizontal*	Average Process Density, lb/ft ³		Liquid Volume Fraction	
	(in)	48" Elev	60" Elev	48" Elev	60" Elev
19209	0	7.39	7.50	0.180	0.183
	12	4.45	5.11	0.105	0.122
19212	0	1.82	1.46	0.038	0.029
	12	1.38	1.52	0.027	0.030
19214	0	1.24	0.96	0.023	0.016
	12	0.88	0.99	0.014	0.017
19216	0	1.64	1.31	0.033	0.025
	12	1.26	1.41	0.024	0.027
19218	0	2.11	1.73	0.045	0.036
	12	1.53	1.77	0.031	0.037
19220	0	2.82	2.41	0.064	0.053
	12	2.23	2.42	0.049	0.053
19222	0	4.00	3.16	0.094	0.073
	12	3.46	3.27	0.080	0.075
19224	0	4.57	4.50	0.110	0.108
	12	4.87	4.71	0.117	0.113
19226	0	6.52	5.91	0.157	0.141
	12	6.76	6.20	0.163	0.149

* Distance from Column Centerline

Table VII
 Process Density and Liquid Volume Fraction
 from Gamma Ray Scans
 Raschig-Super Ring No. 2, 12 ft (3.66 m) Packing Depth
Isobutane/n-Butane System

Run No.	Horizontal*	Average Process Density, lb/ft ³		Liquid Volume Fraction	
	(in)	48" Elev	60" Elev	48" Elev	60" Elev
19230	0	5.53	6.20	0.131	0.154
	12	6.38	7.02	0.160	0.182
19232	0	2.58	2.44	0.032	0.027
	12	2.48	2.49	0.028	0.028
19234	0	3.02	2.90	0.043	0.039
	12	2.94	2.95	0.040	0.040
19236	0	3.51	3.51	0.060	0.060
	12	3.42	3.50	0.057	0.060
19238	0	4.55	4.62	0.096	0.098
	12	4.58	4.75	0.097	0.103
19242	0	2.74	2.70	0.034	0.033
	12	2.70	2.69	0.033	0.033
19244	0	4.91	4.87	0.109	0.107
	12	5.05	5.10	0.113	0.115
19246	0	5.76	6.01	0.138	0.147
	12	6.25	6.25	0.155	0.155
19248	0	5.18	5.44	0.118	0.127
	12	5.68	6.46	0.135	0.163
19250	0	4.44	5.19	0.108	0.132
	12	5.41	5.95	0.139	0.156
19252	0	1.73	1.72	0.025	0.025
	12	1.80	1.76	0.028	0.026
19252	0	1.71	1.70	0.025	0.025
	12	1.77	1.73	0.027	0.025
19254	0	2.15	2.19	0.036	0.037
	12	2.17	2.14	0.037	0.035
19256	0	2.54	2.63	0.048	0.051
	12	2.49	2.48	0.047	0.046
19258	0	3.26	3.43	0.071	0.077
	12	3.36	3.47	0.074	0.078
19260	0	4.26	4.45	0.102	0.108
	12	4.72	4.57	0.117	0.112
19262	0	4.50	5.02	0.109	0.126
	12	5.24	5.64	0.133	0.146
19264	0	4.84	5.28	0.120	0.134
	12	5.42	6.07	0.139	0.159
19266	0	5.44	5.72	0.127	0.137
	12	6.12	6.71	0.151	0.171

* Distance from Column Centerline