

1) Solution of non-linear equation in excel

Book

(1)

Introduction to Chemical Engineering Computing, by Bruce A. Finlayson (wiley)

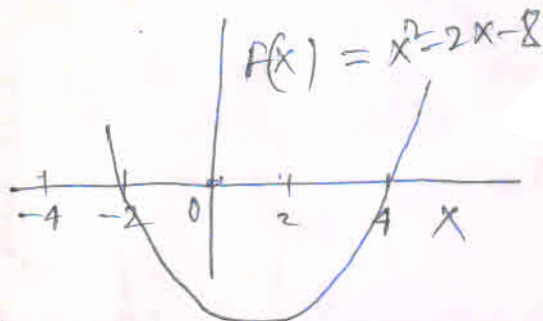
Spreadsheet $F(x) = x^2 - 2x - 8$

A B
 = initial condition = A1 * A1 - 2 * A1 - 8
 = 0

Under Tool chose Goal seek

Set cell \$B\$1
 To value of 0
 By changing cell A1

(8)



-2

4.11E-06

Newton-Raphson $x^{k+1} = x^k - \frac{F(x^k)}{F'(x^k)}$

Put $x^0 = 0$ and iterate till convergence $\left| \frac{x^{k+1} - x^k}{x^k} \right| < 0.001$

2) Solution of linear equation using excel

MINVERSE and MMULT

	A	B	C	D
1	10	5	2	1
2	1	11	4	2
3	3	7	12	3
4				
5				
6	0.105	0.0465		-0.002
7	-1.3E-18	0.11		-0.038
8	-0.02632	-0.0556		0.10627

in A6 Type = MINVERSE (A1:C3)

click cell A6, Press the shift key, select the other corner of the matrix C8. Press F2, the ctrl-shift-enter. inverse appear in A6:C8.

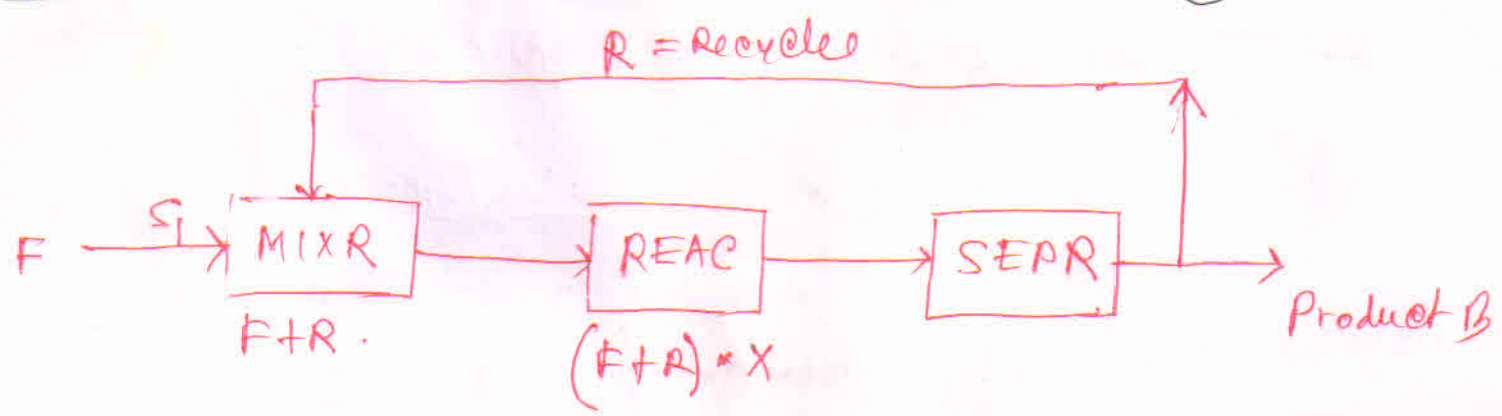
in A11, type = MMULT (A1:D3

, A6:A8) click on cell A11, Press shift key, and select the other corner of the matrix C13. Press F2, the ctrl-shift-enter. Matrix solution appear in A11; A13. in column vector.

calculation of stable recycle rate

Mass balance with recycle of single component

(60)



A → B (40% conversion)

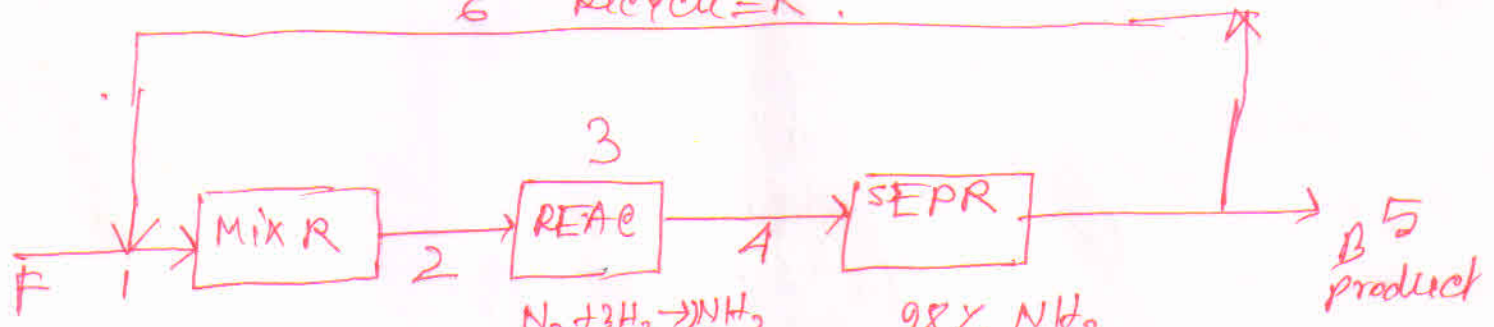
$X = 0.4$

A No of iteration	B Feed	C Recycle guess	D into the reactor = B2 + C2	E Out of the reactor = (1-X)* (B2 + C2)
1	1	0		
2	1	0.6	1.6	0.96
3	1	0.96	1.96	1.176
19	1	1.4998	2.4998	1.499

Mass balance with recycle for Ammonia synthesis

(62)

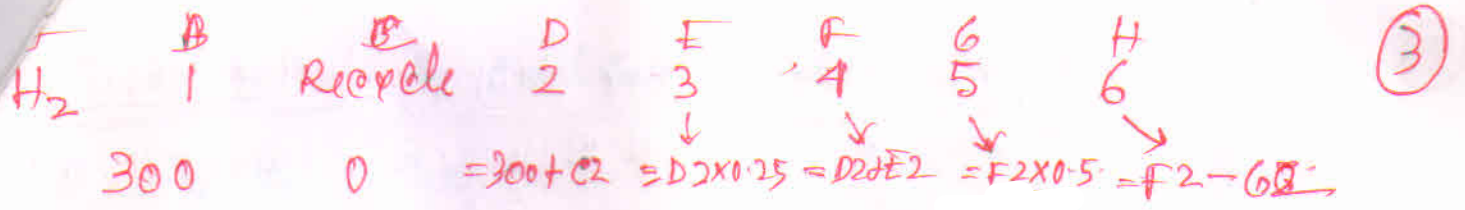
6 Recycle = R



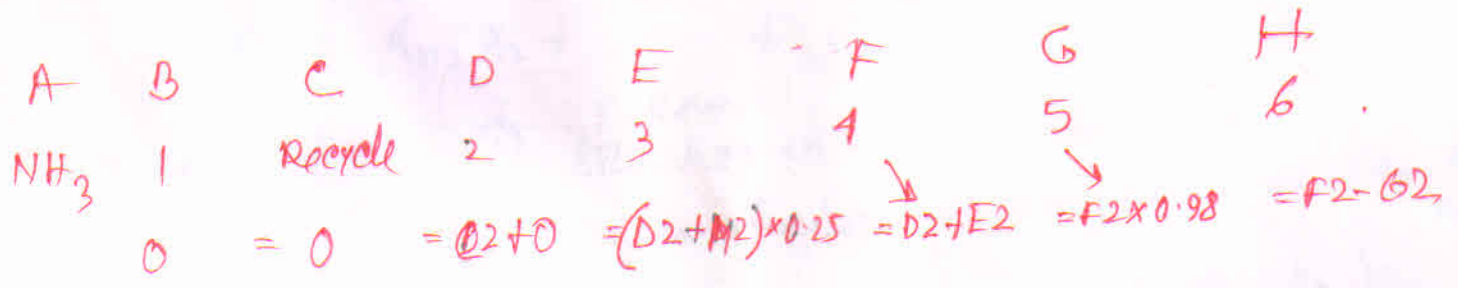
A	B	C	D	E	F	G	H
N ₂	1	Recycle	2	3	4	5	6
	100	0	= 100 + Recycle	= -D2 * 0.25	= D2 + E2	= F2 * 0.5 / 100	= E2 - G2

58 iterations

294.088	394.0887	-98.522	295.5665	1.4778	294.088
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6th iteration 882.266 1182.266 + 295.566 886.6995 4.433 882.266 .



5th iteration = 8.04 = 8.0426 394.088 402.1313 394.0887 8.042626

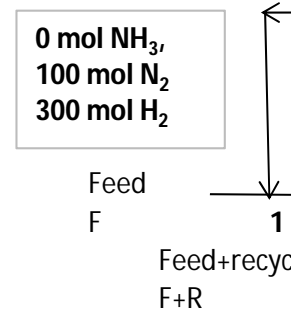
	1 Recycle	2	3	4	5	6		
N2	100	0	100	-25	75	0.375	74.625	H2
	74.625	174.625	-43.6563	130.9688	0.654844	130.3139		
	130.3139	230.3139	-57.5785	172.7354	0.863677	171.8718		
	171.8718	271.8718	-67.9679	203.9038	1.019519	202.8843		
	202.8843	302.8843	-75.7211	227.1632	1.135816	226.0274		
	226.0274	326.0274	-81.5069	244.5206	1.222603	243.298		
	243.298	343.298	-85.8245	257.4735	1.287367	256.1861		
	256.1861	356.1861	-89.0465	267.1396	1.335698	265.8039		
	265.8039	365.8039	-91.451	274.3529	1.371765	272.9811		
	272.9811	372.9811	-93.2453	279.7359	1.398679	278.3372		
	278.3372	378.3372	-94.5843	283.7529	1.418764	282.3341		
	282.3341	382.3341	-95.5835	286.7506	1.433753	285.3168		
	285.3168	385.3168	-96.3292	288.9876	1.444938	287.5427		
	287.5427	387.5427	-96.8857	290.657	1.453285	289.2037		
	289.2037	389.2037	-97.3009	291.9028	1.459514	290.4433		
	290.4433	390.4433	-97.6108	292.8325	1.464162	291.3683		
	291.3683	391.3683	-97.8421	293.5262	1.467631	292.0586		
	292.0586	392.0586	-98.0146	294.0439	1.47022	292.5737		
	292.5737	392.5737	-98.1434	294.4303	1.472151	292.9581		
	292.9581	392.9581	-98.2395	294.7186	1.473593	293.245		
	293.245	393.245	-98.3113	294.9338	1.474669	293.4591		
	293.4591	393.4591	-98.3648	295.0943	1.475472	293.6188		
	293.6188	393.6188	-98.4047	295.2141	1.476071	293.7381		
	293.7381	393.7381	-98.4345	295.3035	1.476518	293.827		
	293.827	393.827	-98.4568	295.3703	1.476851	293.8934		
	293.8934	393.8934	-98.4734	295.4201	1.4771	293.943		
	293.943	393.943	-98.4857	295.4572	1.477286	293.9799		
	293.9799	393.9799	-98.495	295.485	1.477425	294.0075		
	294.0075	394.0075	-98.5019	295.5056	1.477528	294.0281		
	294.0281	394.0281	-98.507	295.5211	1.477605	294.0435		
	294.0435	394.0435	-98.5109	295.5326	1.477663	294.0549		
	294.0549	394.0549	-98.5137	295.5412	1.477706	294.0635		
	294.0635	394.0635	-98.5159	295.5476	1.477738	294.0699		
	294.0699	394.0699	-98.5175	295.5524	1.477762	294.0747		
	294.0747	394.0747	-98.5187	295.556	1.47778	294.0782		
	294.0782	394.0782	-98.5196	295.5587	1.477793	294.0809		
	294.0809	394.0809	-98.5202	295.5606	1.477803	294.0828		
	294.0828	394.0828	-98.5207	295.5621	1.477811	294.0843		
	294.0843	394.0843	-98.5211	295.5632	1.477816	294.0854		
	294.0854	394.0854	-98.5214	295.5641	1.47782	294.0862		
	294.0862	394.0862	-98.5216	295.5647	1.477823	294.0869		
	294.0869	394.0869	-98.5217	295.5651	1.477826	294.0873		
	294.0873	394.0873	-98.5218	295.5655	1.477827	294.0877		
	294.0877	394.0877	-98.5219	295.5657	1.477829	294.0879		
	294.0879	394.0879	-98.522	295.5659	1.47783	294.0881		
	294.0881	394.0881	-98.522	295.5661	1.47783	294.0883		

294.0883	394.0883	-98.5221	295.5662	1.477831	294.0884
294.0884	394.0884	-98.5221	295.5663	1.477831	294.0884
294.0884	394.0884	-98.5221	295.5663	1.477832	294.0885
294.0885	394.0885	-98.5221	295.5664	1.477832	294.0885
294.0885	394.0885	-98.5221	295.5664	1.477832	294.0886
294.0886	394.0886	-98.5221	295.5664	1.477832	294.0886
294.0886	394.0886	-98.5221	295.5664	1.477832	294.0886
294.0886	394.0886	-98.5222	295.5665	1.477832	294.0886
294.0886	394.0886	-98.5222	295.5665	1.477832	294.0886
294.0886	394.0886	-98.5222	295.5665	1.477832	294.0886
294.0886	394.0886	-98.5222	295.5665	1.477832	294.0887
294.0887	394.0887	-98.5222	295.5665	1.477832	294.0887

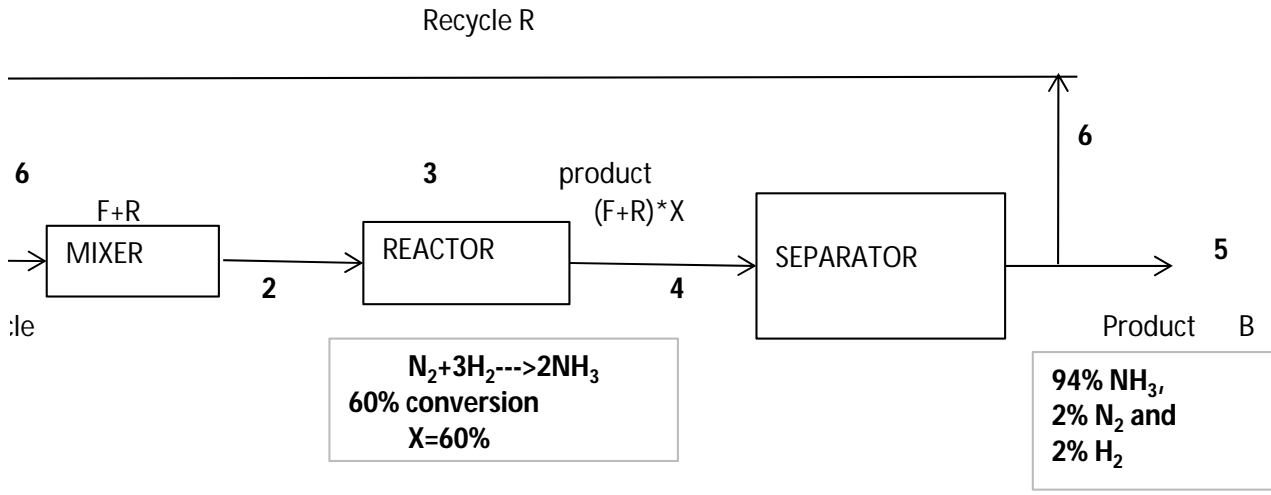
1	Recycle	2	3	4	5	6		1
300	0	300	-75	225	1.125	223.875	NH3	0
	223.875	523.875	-130.969	392.9063	1.964531	390.9417		
	390.9417	690.9417	-172.735	518.2063	2.591031	515.6153		
	515.6153	815.6153	-203.904	611.7114	3.058557	608.6529		
	608.6529	908.6529	-227.163	681.4897	3.407448	678.0822		
	678.0822	978.0822	-244.521	733.5617	3.667808	729.8939		
	729.8939	1029.894	-257.473	772.4204	3.862102	768.5583		
	768.5583	1068.558	-267.14	801.4187	4.007094	797.4116		
	797.4116	1097.412	-274.353	823.0587	4.115294	818.9434		
	818.9434	1118.943	-279.736	839.2076	4.196038	835.0115		
	835.0115	1135.012	-283.753	851.2586	4.256293	847.0024		
	847.0024	1147.002	-286.751	860.2518	4.301259	855.9505		
	855.9505	1155.951	-288.988	866.9629	4.334814	862.6281		
	862.6281	1162.628	-290.657	871.971	4.359855	867.6112		
	867.6112	1167.611	-291.903	875.7084	4.378542	871.3299		
	871.3299	1171.33	-292.832	878.4974	4.392487	874.1049		
	874.1049	1174.105	-293.526	880.5787	4.402893	876.1758		
	876.1758	1176.176	-294.044	882.1318	4.410659	877.7212		
	877.7212	1177.721	-294.43	883.2909	4.416454	878.8744		
	878.8744	1178.874	-294.719	884.1558	4.420779	879.735		
	879.735	1179.735	-294.934	884.8013	4.424006	880.3773		
	880.3773	1180.377	-295.094	885.283	4.426415	880.8565		
	880.8565	1180.857	-295.214	885.6424	4.428212	881.2142		
	881.2142	1181.214	-295.304	885.9106	4.429553	881.4811		
	881.4811	1181.481	-295.37	886.1108	4.430554	881.6803		
	881.6803	1181.68	-295.42	886.2602	4.431301	881.8289		
	881.8289	1181.829	-295.457	886.3717	4.431858	881.9398		
	881.9398	1181.94	-295.485	886.4549	4.432274	882.0226		
	882.0226	1182.023	-295.506	886.5169	4.432585	882.0844		
	882.0844	1182.084	-295.521	886.5633	4.432816	882.1305		
	882.1305	1182.13	-295.533	886.5978	4.432989	882.1648		
	882.1648	1182.165	-295.541	886.6236	4.433118	882.1905		
	882.1905	1182.191	-295.548	886.6429	4.433214	882.2097		
	882.2097	1182.21	-295.552	886.6573	4.433286	882.224		
	882.224	1182.224	-295.556	886.668	4.43334	882.2346		
	882.2346	1182.235	-295.559	886.676	4.43338	882.2426		
	882.2426	1182.243	-295.561	886.6819	4.43341	882.2485		
	882.2485	1182.249	-295.562	886.6864	4.433432	882.253		
	882.253	1182.253	-295.563	886.6897	4.433449	882.2563		
	882.2563	1182.256	-295.564	886.6922	4.433461	882.2587		
	882.2587	1182.259	-295.565	886.6941	4.43347	882.2606		
	882.2606	1182.261	-295.565	886.6954	4.433477	882.262		
	882.262	1182.262	-295.565	886.6965	4.433482	882.263		
	882.263	1182.263	-295.566	886.6972	4.433486	882.2638		
	882.2638	1182.264	-295.566	886.6978	4.433489	882.2643		
	882.2643	1182.264	-295.566	886.6982	4.433491	882.2648		

882.2648	1182.265	-295.566	886.6986	4.433493	882.2651
882.2651	1182.265	-295.566	886.6988	4.433494	882.2653
882.2653	1182.265	-295.566	886.699	4.433495	882.2655
882.2655	1182.265	-295.566	886.6991	4.433496	882.2656
882.2656	1182.266	-295.566	886.6992	4.433496	882.2657
882.2657	1182.266	-295.566	886.6993	4.433496	882.2658
882.2658	1182.266	-295.566	886.6993	4.433497	882.2658
882.2658	1182.266	-295.566	886.6994	4.433497	882.2659
882.2659	1182.266	-295.566	886.6994	4.433497	882.2659
882.2659	1182.266	-295.566	886.6994	4.433497	882.2659
882.2659	1182.266	-295.566	886.6995	4.433497	882.266
882.266	1182.266	-295.566	886.6995	4.433497	882.266
882.266	1182.266	-295.566	886.6995	4.433497	882.266
882.266	1182.266	-295.566	886.6995	4.433497	882.266

Recycle	2	3	4	5	6
0	0	100	100	98	2
2	2	174.625	176.625	173.0925	3.5325
3.5325	3.5325	230.3139	233.8464	229.1695	4.676928
4.676928	4.676928	271.8718	276.5487	271.0177	5.530974
5.530974	5.530974	302.8843	308.4153	302.247	6.168305
6.168305	6.168305	326.0274	332.1957	325.5518	6.643914
6.643914	6.643914	343.298	349.9419	342.943	6.998837
6.998837	6.998837	356.1861	363.1849	355.9212	7.263699
7.263699	7.263699	365.8039	373.0676	365.6062	7.461351
7.461351	7.461351	372.9811	380.4425	372.8336	7.60885
7.60885	7.60885	378.3372	385.946	378.2271	7.718921
7.718921	7.718921	382.3341	390.053	382.252	7.801061
7.801061	7.801061	385.3168	393.1179	385.2555	7.862358
7.862358	7.862358	387.5427	395.405	387.4969	7.908101
7.908101	7.908101	389.2037	397.1118	389.1696	7.942237
7.942237	7.942237	390.4433	398.3855	390.4178	7.96771
7.96771	7.96771	391.3683	399.336	391.3493	7.98672
7.98672	7.98672	392.0586	400.0453	392.0444	8.000906
8.000906	8.000906	392.5737	400.5746	392.5631	8.011493
8.011493	8.011493	392.9581	400.9696	392.9502	8.019393
8.019393	8.019393	393.245	401.2644	393.2391	8.025288
8.025288	8.025288	393.4591	401.4844	393.4547	8.029688
8.029688	8.029688	393.6188	401.6485	393.6156	8.032971
8.032971	8.032971	393.7381	401.771	393.7356	8.035421
8.035421	8.035421	393.827	401.8625	393.8252	8.037249
8.037249	8.037249	393.8934	401.9307	393.8921	8.038613
8.038613	8.038613	393.943	401.9816	393.9419	8.039632
8.039632	8.039632	393.9799	402.0196	393.9792	8.040391
8.040391	8.040391	394.0075	402.0479	394.007	8.040958
8.040958	8.040958	394.0281	402.0691	394.0277	8.041382
8.041382	8.041382	394.0435	402.0849	394.0432	8.041697
8.041697	8.041697	394.0549	402.0966	394.0547	8.041933
8.041933	8.041933	394.0635	402.1054	394.0633	8.042109
8.042109	8.042109	394.0699	402.112	394.0698	8.04224
8.04224	8.04224	394.0747	402.1169	394.0746	8.042338
8.042338	8.042338	394.0782	402.1206	394.0781	8.042411
8.042411	8.042411	394.0809	402.1233	394.0808	8.042466
8.042466	8.042466	394.0828	402.1253	394.0828	8.042506
8.042506	8.042506	394.0843	402.1268	394.0843	8.042537
8.042537	8.042537	394.0854	402.128	394.0854	8.042559
8.042559	8.042559	394.0862	402.1288	394.0862	8.042576
8.042576	8.042576	394.0869	402.1294	394.0869	8.042589
8.042589	8.042589	394.0873	402.1299	394.0873	8.042598
8.042598	8.042598	394.0877	402.1303	394.0877	8.042605
8.042605	8.042605	394.0879	402.1305	394.0879	8.04261
8.04261	8.04261	394.0881	402.1307	394.0881	8.042614



8.042614	8.042614	394.0883	402.1309	394.0882	8.042617
8.042617	8.042617	394.0884	402.131	394.0884	8.04262
8.04262	8.04262	394.0884	402.1311	394.0884	8.042621
8.042621	8.042621	394.0885	402.1311	394.0885	8.042622
8.042622	8.042622	394.0885	402.1312	394.0885	8.042623
8.042623	8.042623	394.0886	402.1312	394.0886	8.042624
8.042624	8.042624	394.0886	402.1312	394.0886	8.042624
8.042624	8.042624	394.0886	402.1312	394.0886	8.042625
8.042625	8.042625	394.0886	402.1313	394.0886	8.042625
8.042625	8.042625	394.0886	402.1313	394.0886	8.042625
8.042625	8.042625	394.0886	402.1313	394.0886	8.042625
8.042625	8.042625	394.0887	402.1313	394.0887	8.042626



	1	Recycle	2	3	4	5	6
Nit	100	0	100	-25	75	0.375	74.625
		74.625	174.625	-43.6563	130.9688	0.654844	130.3139