APPENDIX A: SYSTEM DATA FOR THE UCT SYSTEM OPERATED DURING THE COD/TP STUDY (CHAPTER II)

MLSS mg/L
COD/P=18

An1	1456	1392	1471	1616	1422	1456	1476	1752	1468
An2	1508	1556	1603	1676	1589	1588	1548	1716	1584
Ax1	2264	2904	2942	3000	2798	2476	2952	3308	2744
Ax2	2356	2792	2951	3050	2869	2784	2956	3256	2644
Ae1	2216	2748	2878	2951	2910	2848	2952	3256	3032
Ae2	2392	2732	2860	2940	2874	2728	2912	3208	2872
Ae3	2568	2832	2940	3020	2919	2832	3008	3352	2880
Eff	40	98	68	54	76	72	96	92	26
RAS	4228	3764	4244	5400	4462	4880	3945	4170	4885

MLSS mg/L
COD/P=12

An1	1365	1420	1555	1425	1526	1496	1628	1760	1740
An2	1370	1496	1595	1580	1654	1648	1737	1815	1795
Ax1	2880	2886	2786	3356	3980	3855	3695	3160	3425
Ax2	2847	3415	3810	3915	4125	4015	3745	3300	3180
Ae1	3040	3680	4055	4095	4304	4270	4585	3493	3810
Ae2	2967	3490	4059	4125	4396	4315	4532	3433	3567
Ae3	2988	3670	4035	4190	4390	4328	4688	3440	3680
Eff	72	236	164	112	126	138	108	28	16
RAS	5207	6867	7240	7396	7564	7486	9040	5673	5818

MLSS mg/L
COD/P=8

An1	1855	1748
An2	1802	1888
Ax1	3445	2935
Ax2	3505	3170
Ae1	3680	3335
Ae2	3613	3295
Ae3	3847	3505
Eff	39	103
RAS	6220	5942

PO4-P mg/L

COD/P=18

CI	24.3	17.4	16.2	24.4	16	15.8	21.9
An1	90.6	69	70.4	116	47.4	65	88.3
An2	109	81.7	83.6	129	52	75.6	115
Ax1	49.8	43.1	38.3	70.8	28	44	58
Ax2	56.6	49.1	47.2	83.8	32.4	48.6	68.6
Ae1	20.4	18.9	15.6	13.6	7.7	15.6	20.7
Ae2	6	7.2	7.7	2.2	1.2	1.2	0.9
Ae3	1.1	1.4	0.9	0.3	1	0.4	0.1
Eff	1.3	2.5	0.8	0.2	0.8	0.3	0.2
RAS	1	1.8	0.7	0.2	0.7	0.2	0.1

PO4-P mg/L

COD/P=12

CI	27.2	26.4	26	26.4	26	26.2
An1	118	118	108	106.8	108	120
An2	192	199	170.2	164.2	170.2	170
Ax1	72.6	74	70.4	69.6	70.4	67
Ax2	92.8	90.7	82.2	76.8	82.2	84
Ae1	44.7	36.4	30.8	30.2	30.8	45.8
Ae2	21.8	12.8	11.6	12.4	11.6	20.7
Ae3	4.3	0.9	1.1	1.8	1.1	3.6
Eff	4.1	1.1	1	1.6	1	2.2
RAS	4.1	1	1.1	1.9	1.1	2

PO4-P mg/L

COD/P=8

CI	26	25.7
An1	82	76.9
An2	114	109.4
Ax1	50.1	55.4
Ax2	51	53
Ae1	30.3	34.8
Ae2	19	20.2
Ae3	8.6	9.8
Eff	8.2	10.2
RAS	7.6	9.2

COD	mg/L									
COD/P=18										
CI	455	362	386	411	400	362	440			
An1	141	94	89	81	77	89	103			
An2	107	69	64	72	64	67	87			
Ax1	69	38	32	38	37	32	51			
Ax2	49		30	34	33	21	52			
Ae1	42	26	25	30	31	12	25			
Ae2	39	19	19	31	25	26	22			
Ae3	33	18	22	28	29	18	30			
Eff	35	19	20	27	20	15	23			
RAS	37	18	17	21	9	21	41			

COD	mg/L									
COD/TP=12										
CI	288	290	282	305	303	307	311	294	311	330
An1	61	63	57	69	64	69	70	67	70	59
An2	40	42	40	50	49	52	51	51	51	53
Ax1	32	23	21	42	23	28	38	33	38	28
Ax2	26	19	16	39	20	21	35	27	35	19
Ae1	16	18	16	33	18	20	29	22	29	16
Ae2	12	19	19	26	16	19	25	20	25	14
Ae3	14	20	21	27	18	20	22	21	22	13
Eff	13	19	17	23	18	19	22	20	22	16
RAS	14	19	20	24	19	19	21	20	21	14

COD	mg/L	
COD/P=8		
CI	217	210
An1	39	34
An2	33	32
Ax1	22	20
Ax2	19	18
Ae1	15	12
Ae2	15	12
Ae3	16	14
Eff	15	14
RAS	14	14

PHA	mg/L					
COD/P=18						
An1	158.4	112.1	136.4	125.2	142.8	116
An2	211.7	133.4	157.6	177.8	194.9	162
Ax1	120	92.1	88	104.9	105.1	96.6
Ax2	138	94.9	102.6	111.2	131.1	108
Ae1	88.6	66.9	71.9	73.7	83	60
Ae2	68	57.1	61.2	57.7	61.8	62.2
Ae3	63.6	67	57.2	51.3	54.3	66.6
Ras	81.6	78.9	66.2	71.1	58.8	76.9

PHA	mg/L					
COD/P=12						
An1	99.8	111.6	132.8	124.1	100.2	95.7
An2	129.7	135.8	152.7	161.7	122.1	127.6
Ax1	68.1	98.4	92.7	108.2	114.5	98.8
Ax2	78	94.9	112.6	111.2	131.1	116.8
Ae1	71.4	61.1	90.2	93.3	98.7	77.8
Ae2	65.1	68.8	80.9	77.4	83.3	67
Ae3	62.4	61.8	79.2	72.5	78.2	62.1
Ras						

PHA	mg/L	
COD/P=8		
An1	64.8	49.8
An2	75.8	71
Ax1	52.1	39.7
Ax2	44	39.4
Ae1	43.1	36.3
Ae2	37.4	40.6
Ae3	41	38.2
Ras	53.3	44.7

Glycogen mg/L **COD/P=18**								
An1	108.3	98.2	112.2	79.9	93	121	134	71.4
An2	77.3	91.7	82.9	109	61	120	83	84
Ax1	275	314	277	237	305	321	338	327
Ax2	333	287	276	277	302	318	299	282
Ae1	307	324	298	346	335	338	351.5	344
Ae2	314	328	306	262	327	354	411	391
Ae3	329	308	339	328	343	352	345	350
Ras	697	652	512	609	688	588	602	594

Glycogen mg/L **COD/P=12**						
An1	87	65	92	61	76	73
An2	83	57	89	46	70	39
Ax1	228	197	209	171	273.5	205
Ax2	219	192	207	169	270	204
Ae1	223	199	232	187	289	245
Ae2	226	201	237	190	313	246
Ae3	227	204	241	177	314	247
Ras	537	415	492	402	472	434

Glycogen mg/L **COD/P=8**		
An1	52	62
An2	45	57
Ax1	134.9	161.1
Ax2	135	169.8
Ae1	133	171
Ae2	130	173
Ae3	137	166.7
Ras	312	282

APPENDIX B: SYSTEM DATA FOR THE A/O, UCT 20°C AND UCT 5°C UNITS(CHAPTER III)

9/18/00														
Reactor	**COD**	**NO2-N**	**NO3-N**	**NH4-N**	**PO4-P**	**SO4**	**K**	**Mg**	**PHB**	**PHV**	**PHA**	**MLSS**	**MLVSS**	**%VSS**
	mg/L	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	
Inf	411			29	17									
A1	68	nd	nd	19	155	39	57	58	65	9.5	74	2825	1962	0.69
A2	52	nd	nd		162	35			126	19	145			
A3	43	nd	nd		172	44			128	19	147	3012	2082	0.69
A4	36	nd	1.98	6.1	36	36	31	36	62	10	72	3984	2482	0.62
A5	38	nd	3.43		8.5	37			21	5.4	27			
A6	35	nd	3.94	nd	0	37	20	29	21	5.4	26	3488	2150	0.62
Eff	29	nd	3.84		0	37						74	56	0.76
RAS	48	nd	nd		0.06	41			43	8.0	51	6015	3629	
COD/TP	24													

10/30/00														
Reactor	**COD**	**NO2-N**	**NO3-N**	**NH4-N**	**PO4-P**	**SO4**	**K**	**Mg**	**PHB**	**PHV**	**PHA**	**MLSS**	**MLVSS**	**%VSS**
	mg/L	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	
Inf	407			28	24									
A1	55	nd	nd		78.0	39.8			65	18	83	2422	1762	0.73
A2	50	nd	nd		85.7	43.2			66	18	85	3549		
A3	45	nd	nd		86.0	43.1			67	18	86	4676	3324	0.71
A4	40	nd	2.17	7.2	13.3	37.3			45	9.5	55	4686	3195	0.68
A5	44	nd	3.25		0.94	36.7			36	6.2	42	4884		
A6	40	nd	3.55	nd	0.0	36.5			32	5.9	38	5081	3281	0.65
Eff	31	nd	3.06		0.12	36.9						77	46	
RAS	52	nd	3.05		0.0	36.9			15	17	32	2624	1752	0.67
COD/TP	17													

12/7/00														
Reactor	**COD**	**NO2-N**	**NO3-N**	**NH4-N**	**PO4-P**	**SO4**	**K**	**Mg**	**PHB**	**PHV**	**PHA**	**MLSS**	**MLVSS**	**%VSS**
	mg/L	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	
Inf	458			29	20									
A1	71	nd	nd	19	96	35	57	58	105	18	122	3770	2760	0.73
A2	59	nd	nd		103	37			125	21	145			
A3	50	nd	nd		103	39			126	20	146	4692	3443	0.73
A4	44	nd	2.46	6.1	47	35	31	36	105	16	121	5380	3805	0.71
A5	50	nd	4.37		16	34			82	14	96			
A6	50	nd	4.47	nd	8	33	20	29	41	9.2	50	5010	3410	0.68
Eff	38	nd	4.10		16	35						107	70	
RAS	35	nd	0.41		23	34			50	9.3	59	5722	3947	0.69
COD/TP	22													

12/21/00														
Reactor	**COD**	**NO2-N**	**NO3-N**	**NH4-N**	**PO4-P**	**SO4**	**K**	**Mg**	**PHB**	**PHV**	**PHA**	**MLSS**	**MLVSS**	**%VSS**
	mg/L	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	
Inf	438			20	22									
A1	29	nd	nd	11.6	70	34	33	28	56	8	36	3867	2774	0.72
A2	27	nd	nd		74	35			81	14	71			
A3	24	nd	nd	10.8	78	37	37	32	161	40	201	3713	2692	0.73
A4	24	nd	1.76	0	19	34	22	19	60	19	79	4610	3200	0.69
A5	27	nd	2.38		3	34			47	15	64			
A6	23	nd	2.48	0	0	35	15	14	30	9.3	40	4910	3330	0.68
Eff	20	nd	2.36		0	34						73	56	0.77
RAS	20	nd	1.45		0.02	35			12	3.3	15	5429	3671	0.68
COD/TP	20													

1/11/01																	
Reactor	**COD**	**NO2-N**	**NO3-N**	**NH4-N**	**PO4-P**	**TP**	**TP**	**SO4**	**K**	**Mg**	**PHB**	**PHV**	**PHA**	**Glycogen**	**MLSS**	**MLVSS**	**%VSS**
	mg/L	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**%VSS**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	
Inf	442			31	35												
A1	53	nd	nd	14.6	73	247	9.1	24	60	38	38	10	48	342	3840	2720	0.71
A2	48	nd	nd		75			23			45	11	56	327	4224	3000	0.71
A3	45	nd	nd	12.9	76	289	8.7	24	61	39	64	15	79	304	4609	3310	0.72
A4	36	nd	2.70	0	27	316	9.2	28	44	27	37	10	48	381	5052	3445	0.68
A5	37	nd	3.17		8			28			33	7.9	41	426	5016	3361	0.67
A6	37	nd	3.14	0	1	314	9.5	27	36	19	26	6.0	32	432	4981	3322	0.67
Eff	37	nd	3.07		2			26							85	60	
RAS	39	nd	1.7		1.6	308	9.7	27			31	7.7	38	530	4731	3179	0.67
COD/TP	13																

1/18/01																	
Reactor	**COD**	**NO2-N**	**NO3-N**	**NH4-N**	**PO4-P**	**TP**	**TP**	**SO4**	**K**	**Mg**	**PHB**	**PHV**	**PHA**	**Glycogen**	**MLSS**	**MLVSS**	**%VSS**
	mg/L	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**%VSS**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	
Inf	472			34	20												
A1	48	nd	nd	14.6	70	247	8.5	30	60	38	78	16	93	274	2724	2095	0.77
A2	36	nd	nd		75			30			110	23	132	261	3037	2308	0.76
A3	37	nd	nd	12.9	76	289	8.3	31	61	39	119	25	143	237	3351	2553	0.76
A4	39	nd	0.40	0	40	316	8.4	31	44	27	77	24	101	319	4519	3294	0.73
A5	36	nd	3.30		17			30			63	19	81	367	4056	2920	0.72
A6	26	nd	4.60	0	4	314	12.1	30	36	19	21	6.2	27	369	3594	2552	0.71
Eff	39	nd	4.70		6			30							68	55	
RAS	32	nd	1.7		3.80	308	10.8	29			23	7.5	30	472	3921	2816	0.72
COD/TP	24																

1/26/01																	
Reactor	**COD**	**NO2-N**	**NO3-N**	**NH4-N**	**PO4-P**	**TP**	**TP**	**SO4**	**K**	**Mg**	**PHB**	**PHV**	**PHA**	**Glycogen**	**MLSS**	**MLVSS**	**%VSS**
	mg/L	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**%VSS**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	
Inf	441			28	30												
A1	34	nd	nd	12.7	74	311	8.6	34	52	43	55	14	69	381	3765	2740	0.73
A2	38	nd	nd		75			34			62	17	79	354	3865	2783	0.72
A3	29	nd	nd	10.7	75	202	4.4	36	51	43	84	28	112	342	3965	2890	0.73
A4	29	nd	1.80	0	22	235	6.1	36	38	32	40	13	53	520	4924	3481	0.71
A5	24	nd	2.70		8			36			18	5.2	23	512	4838	3339	0.69
A6	24	nd	2.70	0	2	268	8.2	36	30	26	9.2	4.1	13	519	4753	3263	0.69
Eff	30	nd	2.60		3			36							106	70	
RAS	26	nd	1.5		1.1	309	8.2	36			15	5.4	20	641	5448	3750	0.69
COD/TP	14.9																

2/1/01																
Reactor	**NO2-N**	**NO3-N**	**NH4-N**	**PO4-P**	**SO4**	**K**	**Mg**	**PHB**	**PHV**	**PHA**	**Glycogen**	**OUR**	**pH**	**MLSS**	**MLVSS**	**%VSS**
	mg/L	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L/hr**		**mg/L**	**mg/L**	
Inf			31	30												
A1	nd	nd	13.5	66	27	61	38	70.04	17.0	87.1	396		7.72	3714	2764	0.74
A2	nd	nd		71	29			99.21	25.9	125.1	372		7.63	4083		
A3	nd	nd	12.4	72	27	63	39	112.00	31.1	143.1	356		7.59	4452	3312	0.74
A4	nd	1.50	2.7	33	28	50	27	36.22	8.2	44.5	471	90.0	8.06	4656	3366	0.72
A5	nd	2.80		14	27			15.65	4.1	19.7	483	32.8	8.51	4966.5		
A6	nd	2.90	0	5	26	38	19	15.39	3.1	18.5	481	38.2	8.56	5277	3729	0.71
Eff	nd	2.70		5	27									122	85	
RAS	nd	1.8		4	26	*-0.88*		48.38	14.61	63.0	667			6792	4792	0.71

2/15/01																				
Reactor	**COD**	**NO2-N**	**NO3-N**	**NO3-N**	**NH4-N**	**TP**	**TP**	**PO4-P**	**SO4**	**K**	**Mg**	**PHB**	**PHV**	**PHA**	**Glycogen**	**OUR**	**pH**	**MLSS**	**MLVSS**	**%VSS**
	mg/L	**mg/L**	**mg/L**	**mg/d**	**mg/L**	**mg/L**	**%VSS**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L/hr**		**mg/L**	**mg/L**	
Inf	469		0	0	39			21	0											
A1	51	nd	0	176	13.5	206	4.9	69	27	61	38	34	7.1	41	273		7.72	3840	2795	0.73
A2	44	nd	0	0		220	4.6	71	29			34	7.0	41	264		7.63	4431	3231	0.73
A3	38	nd	0	0	12.4	215	4.7	73	27	63	39	34	7.3	42	259		7.59	4238	3047	0.72
A4	32	nd	2.30	-189	2.73	279	7.6	35	28	50	27	18	5.3	24	312	121.3	8.06	4548	3211	0.71
A5	33	nd	5.00	-222		239	8.1	16	27			12	4.2	16	324	41.8	8.51	4055	2760	0.68
A6	32	nd	5.40	-33	0	285	8.2	6	26	38	19	11	3.0	14	319	29.5	8.56	4933	3400	0.69
Eff	32	nd	5.30	160				7	27									60	43	0.72
RAS	30	nd	3.4			288	7.3	***4***				11	2.2	13	464			5738	3919	0.68
COD/TP	22.8																			

3/8/01																			
Reactor	**COD**	**NO2-N**	**NO3-N**	**NH4-N**	**TP**	**TP**	**PO4-P**	**SO4**	**K**	**Mg**	**PHB**	**PHV**	**PHA**	**Glycogen**	**OUR**	**pH**	**MLSS**	**MLVSS**	**%VSS**
	mg/L	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**%VSS**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L/hr**		**mg/L**	**mg/L**	
Inf	422		0	35			22	16	9	30									
A1	44	nd	0	14.0	206	7.5	54	36	53	39	47	9.8	58	181		7.72	2900	2030	0.70
A2	42	nd	0		220	6.9	57	33			46	9.6	56	162		7.63	3335	2365	0.71
A3	48	nd	0	12.8	215	6.2	63	41	59	39	46	10	56	158		7.59	3410	2450	0.72
A4	23	nd	0.60	5.91	279		21	33	34	30	26	7.5	35	267	94.3	8.06			
A5	28	nd	2.60		239	10.5	6	33			21	5.2	27	274	49.3	8.51	3360	2220	0.66
A6	26	nd	3.50	0	285	11.2	0	32	29	23	16	4.3	21	278	24.5	8.56	3800	2535	0.67
Eff	22	nd	2.60				3	31									34	23	0.68
RAS	22	nd	2.5		288	10.2	***4***	32	*-0.83*		16	3.2	20	348			4116	2774	0.67
COD/TP	19																		

11/5/01													
Reactor	**COD**	**NO2-N**	**NO3-N**	**NH4-N**	**PO4-P**	**PHB**	**PHV**	**PHA**	**Glycogen**	**OUR**	**MLSS**	**MLVSS**	**%VSS**
	mg/L	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L/hr**	**mg/L**	**mg/L**	
Inf	560		0	16	25								
A1	56	nd	0	10.2	115	171	32	202	155		4487	2616	0.58
A2	10	nd	0		122	186	35	221	150		4849	2822	0.58
A3	27	nd	0		137	189	38	226	123		4759	2741	0.58
A4	21	nd	0.22	4.6	36	133	26	159	149	152.3	5626	3140	0.56
A5	17	nd	0.41		5	94	17	111	142	86.4	5142	2726	0.53
A6	8	nd	0.57	0	1	65	15	80	231	60.1	5821	3218	0.55
Eff	18	nd	0.48		2	0	0	0			279	127	0.46
RAS	18	nd	0.5		***2***	183	41	224	537		12864	7632	0.59
COD/TP	23												

System re-started with sludge from 5C UCT system in November 2001.

11/8/01														
Reactor	**COD**	**TCOD**	**NO2-N**	**NO3-N**	**NH4-N**	**PO4-P**	**PHB**	**PHV**	**PHA**	**Glycogen**	**OUR**	**MLSS**	**MLVSS**	**%VSS**
	mg/L	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L/hr**	**mg/L**	**mg/L**	
Inf	502			0	16	25								
A1	32		nd	0	9.3	140	142	23	166	154		4830	3088	0.64
A2	21		nd	0		142	199	34	232	146		5481	3534	0.64
A3	24		nd	0		147	184	30	214	141		5389	3489	0.65
A4	24		nd	0.21	4.7	38	113	20	133	187	143.6	6640	3949	0.59
A5	19		nd	0.65		3.6	96	16	112	193	68.4	5621	3339	0.59
A6	19		nd	0.87	0	0.2	97	16	113	273	56.5	7729	4588	0.59
Eff	16		nd	0.83		0.1						153	98	0.64
RAS	18		nd	0.1		3.1	98	16	114	351		7552	4454	0.59
COD/TP	20													

11/13/01									
Reactor	**COD**	**NO2-N**	**NO3-N**	**NH4-N**	**PO4-P**	**OUR**	**MLSS**	**MLVSS**	**%VSS**
	mg/L	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L/hr**	**mg/L**	**mg/L**	
Inf	489		0	16	25				
A1	26	nd	0	9.1	137		4980	3223	0.65
A2	31	nd	0		139		5589	3665	0.66
A3	30	nd	0		141		5678	3698	0.65
A4	21	nd	0.27	3.9	32	131.8	6245	3658	0.59
A5	20	nd	0.75		2.7	63.7	5887	3452	0.59
A6	22	nd	0.88	0	0.1	51.2	7860	4751	0.60
Eff	19	nd	0.78		0.5		132	74	0.56
RAS	17	nd	0.14		***3.1***		7552	4454	0.59
COD/TP	20								

11/15/01													
Reactor	**COD**	**NO2-N**	**NO3-N**	**NH4-N**	**PO4-P**	**PHB**	**PHV**	**PHA**	**Glycogen**	**OUR**	**MLSS**	**MLVSS**	**%VSS**
	mg/L	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L/hr**	**mg/L**	**mg/L**	
Inf	565		0	22	0								
A1	31	nd	0	11.8	75	245	38	283	128		3432	2695	0.79
A2	33	nd	0		76	272	55	328	113		3711	2947	0.79
A3	26	nd	0		74	275	57	333	102		3760	2994	0.80
A4	22	nd	0.19	5.7	24	196	38	234	164	136.8	4826	3413	0.71
A5	20	nd	0.40		0	180	34	214	157	81.0	4678	3120	0.67
A6	24	nd	0.59	0	0	184	32	217	220	56.9	4848	3470	0.72
Eff	23	nd	0.52		0						160	120	0.75
RAS	19	nd	0.2			251	47	298	341		7034	5145	0.73
COD/TP	N/A												

Sludge phosphate reserves drained and phosphate feed shut down on 11/14/01.

11/29/01													
Reactor	**COD**	**NO2-N**	**NO3-N**	**NH4-N**	**PO4-P**	**PHB**	**PHV**	**PHA**	**Glycogen**	**OUR**	**MLSS**	**MLVSS**	**%VSS**
	mg/L	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L/hr**	**mg/L**	**mg/L**	
Inf	520		0	19	0								
A1	38	nd	0	11.5	39	330	69	400	149		2726	2423	0.89
A2	32	nd	0		54	420	84	504	134		3006	2659	0.88
A3	32	nd	0		57	423	89	512	117		2902	2609	0.90
A4	29	nd	0.11	5.6	7	331	76	407	181	93.6	4450	3470	0.78
A5	27	nd	0.43		0	273	60	334	199	67.0	3401	2850	0.84
A6	21	nd	0.46	0	0	275	58	333	281	66.2	3827	3178	0.83
Eff	21	nd	0.39		0						33		0.00
RAS	20	nd	0		0	383	84	467	353		5115	4224	0.83
COD/TP	N/A												

12/6/01													
Reactor	**COD**	**NO2-N**	**NO3-N**	**NH4-N**	**PO4-P**	**PHB**	**PHV**	**PHA**	**Glycogen**	**OUR**	**MLSS**	**MLVSS**	**%VSS**
	mg/L	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L/hr**	**mg/L**	**mg/L**	
Inf	640		0	20	0								
A1	57	nd	0	10.4	17	376	103	479	169		3016	2621	0.87
A2	41	nd	0		28	477	152	629	130		3675	3185	0.87
A3	31	nd	0		33	506	159	665	123		3838	3373	0.88
A4	21	nd	0.22	4.1	0	456	127	583	164	106.2	3985	3330	0.84
A5	22	nd	0.60		0	386	105	492	161	81.4	3367	2858	0.85
A6	16	nd	0.47	0	0	352	83	435	184	78.1	3710	3115	0.84
Eff	18	nd	0.55		0						98	82	0.84
RAS	19	nd	0.04		0	501	133	634	411		5415	4500	0.83
COD/TP	N/A												

7/16/01												
SYS 1 @ 20 ^{0} C.												
Location	**COD**	**SS**	**VSS**	**VSS/SS**	**NO_3-N**	**PO_4-P**	**Ac**	**NH_4-N**	**PHB**	**PHV**	**PHA**	**Glycogen**
	mg/L	**mg/L**	**mg/L**		**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Synt. Feed	481				0	0	432	36				
PO4-P Feed					0	566	0					
Comb. Inf.	451				0	36	405	34				
Anaerobic 1	119	2894	2077	0.72	0	129	75		158	15	173	112
Anaerobic 2	40	2846	2065	0.73	0	161	0		190	27	217	88
Anoxic 1	34	4518	3242	0.72	0	105	0		149	17	166	293
Anoxic 2	26	4479	3230	0.72	0	109	0		151	22	173	290
Aerobic 1	28	4599	3298	0.72	5.3	22	0	4.9	72	8	80	335
Aerobic 2	26	4686	3301	0.70	7.4	5.4	0	1.7	50	5	55	361
Aerobic 3	24	4737	3290	0.70	7.8	1.6	0	0.6	46	1	47	369
Effluent	26	42	28	0.67	7.3	1.9	0	1				
RAS	28	7590	5299	0.70	7	1.3	0	0.6	72	7	79	682

8/6/01												
SYS 1 @ 20 ^{0} C.												
Location	**COD**	**SS**	**VSS**	**VSS/SS**	**NO_3-N**	**PO_4-P**	**Ac**	**NH_4-N**	**PHB**	**PHV**	**PHA**	**Glycogen**
	mg/L	**mg/L**	**mg/L**		**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Synt. Feed	479				0	0	454	40				
PO4-P Feed					0	608	0					
Comb. Inf.	449				0	39.0	425	38				
Anaerobic 1	129	2954	2108	0.71	0	148	82		149	33	182	119
Anaerobic 2	46	2916	2100	0.72	0	181	0		196	29	225	104
Anoxic 1	36	4600	3266	0.71	0	113	0		151	24	175	304
Anoxic 2	28	4577	3300	0.72	0	115.9	0		154	25	179	301
Aerobic 1	30	4799	3346	0.70	4.7	26	0	6.6	72	12	84	348
Aerobic 2	24	4846	3398	0.70	6.5	7	0	3.5	49	10	59	364
Aerobic 3	30	4859	3321	0.68	6.8	2	0	2	42	8	50	367
Effluent	30	23	16	0.70	6.8	1.8	0	1.8				
RAS	28	7711	5376	0.70	6.4	1.2	0	1.1	75	12	87	654

8/21/01												
SYS 1 @ 20 ^{0} C.												
Location	**COD**	**SS**	**VSS**	**VSS/SS**	**NO_3-N**	**PO_4-P**	**Ac**	**NH_4-N**	**PHB**	**PHV**	**PHA**	**Glycogen**
	mg/L	**mg/L**	**mg/L**		**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Synt. Feed	489				0	0	442	41				
PO4-P Feed					0	636	0					
Comb. Inf.	458				0	41	414	38				
Anaerobic 1	136	2857	2100	0.74	0	137	84		152	27	179	129
Anaerobic 2	48	2836	2087	0.74	0	164	0		187	37	224	106
Anoxic 1	34	4479	3210	0.72	0	105	0		140	29	169	308
Anoxic 2	26	4401	3196	0.73	0	110	0		153	21	174	304
Aerobic 1	28	4529	3128	0.69	4.9	23	0	7	68	14	82	354
Aerobic 2	26	4617	3245	0.70	6.8	7	0	3.8	47	12	59	379
Aerobic 3	24	4699	3219	0.69	6.7	3.8	0	2.2	39	8	47	385
Effluent	26	49	32	0.65	6.8	4.2	0	2.1				
RAS	28	7410	5235	0.71	6.3	2.7	0	1.5	72	0	72	675

8/27/01

SYS 1 @ 20 ^{0} C.

Location	**COD**	**SS**	**VSS**	**VSS/SS**	**NO_3-N**	**PO_4-P**	**Ac**	**NH_4-N**	**PHB**	**PHV**	**PHA**	**Glycogen**
	mg/L	**mg/L**	**mg/L**		**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Synt. Feed	476				0	0	466	38				
PO4-P Feed					0	619	0					
Comb. Inf.	445				0	40	436	34				
Anaerobic 1	124	3014	2165	0.72	0	145	89		147	22	169	111
Anaerobic 2	42	2983	2177	0.73	0	179	0		181	23	204	92
Anoxic 1	36	4569	3266	0.72	0	112	0		133	19	152	294
Anoxic 2	26	4580	3224	0.70	0	116	0		144	13	157	292
Aerobic 1	24	4696	3249	0.69	5.1	26	0	7.4	62	9	71	352
Aerobic 2	24	4799	3268	0.68	6.6	9.4	0	3.2	42	13	55	370
Aerobic 3	23	4862	3290	0.68	6.9	2.6	0	2	36	15	51	371
Effluent	24	30	20	0.67	6.6	3.1	0	2.1				
RAS	26	7602	5279	0.69	6.4	2.5	0	1.6	61	6	67	651

6/28/01												
SYS 2 @ 5^0 C.												
Location	**COD**	**SS**	**VSS**	**VSS/SS**	**NO_3-N**	**PO_4-P**	**Ac**	**NH_4-N**	**PHB**	**PHV**	**PHA**	**Glycogen**
	mg/L	**mg/L**	**mg/L**		**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Synt. Feed	NM				0	0	464	24.6				
PO4-P Feed					0	2404	0					
Comb. Inf.	NM				0	114.5	442.0	23.4				
Anaerobic 1	NM	3640	2625	0.721	0	182.2	127.5	23.8	199	12	211	156.0
Anaerobic 2	NM	3563	2645	0.742	0	205	96	7	238	28	266	138.0
Anoxic 1	NM	6144	4283	0.697	0	159.1	0	7.1	252	7	259	322.0
Anoxic 2	NM	6152	4265	0.693	0	173.5	0	12.4	249	17	266	316.0
Aerobic 1	NM	6592	4321	0.655	0.6	57.9	0	7.3	155	13	168	352.0
Aerobic 2	NM	6696	4300	0.642	1.5	4.4	0	3.8	104	15	119	369.0
Aerobic 3	NM	6748	4277	0.634	2.4	0	0	1.1	90	7	97	373.0
Effluent	NM	44	27	0.614	2.2	0	0	1.2				
RAS	NM	11452	7301	0.638	1.4	0	0	0.9	112	13	125	696

7/2/01												
SYS 2 @ 5^0 C.												
Location	**COD**	**SS**	**VSS**	**VSS/SS**	**NO_3-N**	**PO_4-P**	**Ac**	**NH_4-N**	**PHB**	**PHV**	**PHA**	**Glycogen**
	mg/L	**mg/L**	**mg/L**		**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Synt. Feed	480				0	0	489	34				
PO4-P Feed					0	3243	0					
Comb. Inf.	456				0	163	465	33				
Anaerobic 1	159	4172	2896	0.69	0	234	106	29	208	41	249	160
Anaerobic 2	123	4120	2922	0.71	0	258	76	30	266	21	287	148
Anoxic 1	34	7098	4780	0.67	0	206	0	26	232	36	268	319
Anoxic 2	30	7162	4907	0.69	0	225	0	27	269	20	289	309
Aerobic 1	32	7532	4926	0.65	1.9	133	0	22	164	13	177	346
Aerobic 2	28	7704	4870	0.63	2.7	76	0	17	107	12	119	361
Aerobic 3	28	7812	4793	0.61	3	37	0	14	87	2	89	369
Effluent	32	28	19	0.68	3	34	0	14				
RAS	26	13014	8200	0.63	2.4	46	0	17	129	2	131	680

7/5/01												
SYS 2 @ 5^0 C.												
Location	**COD**	**SS**	**VSS**	**VSS/SS**	**NO_3-N**	**PO_4-P**	**Ac**	**NH_4-N**	**PHB**	**PHV**	**PHA**	**Glycogen**
	mg/L	**mg/L**	**mg/L**		**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Synt. Feed	480				0	0	446	36				
PO4-P Feed					0	3580	0					
Comb. Inf.	456				0	180	424	34				
Anaerobic 1	159	4389	2914	0.66	0	273	113	28	186	38	224	143
Anaerobic 2	123	4337	2940	0.68	0	292	85	29	231	28	259	137
Anoxic 1	34	7216	4697	0.65	0	246	0	24	222	22	244	298
Anoxic 2	30	7209	4748	0.66	0	266	0	26	215	52	267	292
Aerobic 1	32	7496	4792	0.64	1.6	163	0	20	147	4	151	348
Aerobic 2	28	7688	4769	0.62	2.3	110	0	16	94	6	100	369
Aerobic 3	28	7869	4782	0.61	2.8	68	0	13	70	3	73	378
Effluent	32	52	34	0.65	3	67	0	12				
RAS	26	13482	8151	0.60	2.4	85	0	16	90	10	100	644

7/9/01												
SYS 2 @ 5^0 C.												
Location	**COD**	**SS**	**VSS**	**VSS/SS**	**NO_3-N**	**PO_4-P**	**Ac**	**NH_4-N**	**PHB**	**PHV**	**PHA**	**Glycogen**
	mg/L	**mg/L**	**mg/L**		**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Synt. Feed	NM				0	0	469	33				
PO4-P Feed					0	3394	0					
Comb. Inf.	NM				0	172	445	31.3				
Anaerobic 1	NM	4446	2844	0.64	0	268	127	NM	167	17	184	182
Anaerobic 2	NM	4469	2819	0.63	0	284	102	NM	185	17	202	179
Anoxic 1	NM	7328	4549	0.62	0	242	0	NM	172	24	196	351
Anoxic 2	NM	7294	4487	0.62	0	260	0	NM	194	20	214	342
Aerobic 1	NM	7582	4522	0.60	2	168	0	NM	114	9	123	360
Aerobic 2	NM	7711	4468	0.58	2.5	124	0	NM	79	5	84	377
Aerobic 3	NM	7800	4506	0.58	2.8	92	0	NM	64	5	69	385
Effluent	NM	33	16	0.48	2.9	89	0	7				
RAS	NM	14107	8563	0.61	2.2	99	0	NM	94	6	100	680

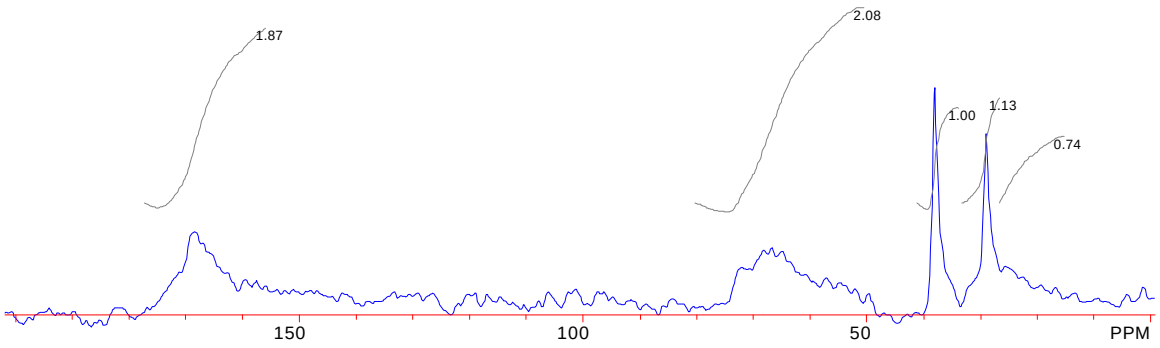
7/12/01												
SYS 2 @ 5^0 C.												
Location	**COD**	**SS**	**VSS**	**VSS/SS**	**NO_3-N**	**PO_4-P**	**Ac**	**NH_4-N**	**PHB**	**PHV**	**PHA**	**Glycogen**
	mg/L	**mg/L**	**mg/L**		**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Synt. Feed	510				0	0	486	24.6				
PO4-P Feed					0	3134	0					
Comb. Inf.	484				0	163	461	23.4				
Anaerobic 1	186	4683	2924	0.62	0	237	151	23.8	206	12	218	175
Anaerobic 2	160	4596	2897	0.63	0	256	119	7	229	22	251	168
Anoxic 1	36	7639	4568	0.60	0	208	0	7.1	218	23	241	321
Anoxic 2	28	7568	4582	0.61	0	222	0	12.4	246	12	258	316
Aerobic 1	30	7845	4507	0.57	2	135	0	7.3	158	14	172	331
Aerobic 2	32	7992	4412	0.55	2.5	95	0	3.8	117	2	119	339
Aerobic 3	30	8087	4436	0.55	2.9	70	0	1.1	83	6	89	349
Effluent	30	61	34	0.56	2.9	68	0	1.2				
RAS	34	14397	8169	0.57	2.1	70	0	0.9	111	11	122	616

7/16/01												
SYS 2 @ 5^0 C.												
Location	**COD**	**SS**	**VSS**	**VSS/SS**	**NO_3-N**	**PO_4-P**	**Ac**	**NH_4-N**	**PHB**	**PHV**	**PHA**	**Glycogen**
	mg/L	**mg/L**	**mg/L**		**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Synt. Feed	472				0	0	445	29.1				
PO4-P Feed					0	2422	0					
Comb. Inf.	447				0	126	422	27.6				
Anaerobic 1	174	4884	2891	0.59	0	227	131	NM	180	9	189	161
Anaerobic 2	142	4953	2952	0.60	0	248	94	NM	202	21	223	147
Anoxic 1	49	8169	4611	0.56	0	200	0	NM	196	18	214	320
Anoxic 2	34	8022	4630	0.58	0	220	0	NM	219	20	239	312
Aerobic 1	36	8453	4722	0.56	1.3	125	0	NM	158	4	162	346
Aerobic 2	44	8617	4645	0.54	1.8	70	0	6.6	100	7	107	359
Aerobic 3	32	8769	4578	0.52	2	39	0	3.7	65	10	75	364
Effluent	36	26	17	0.65	1.9	38	0	3.2				
RAS	30	16348	8942	0.55	1.6	45	0	NM	97	21	118	660

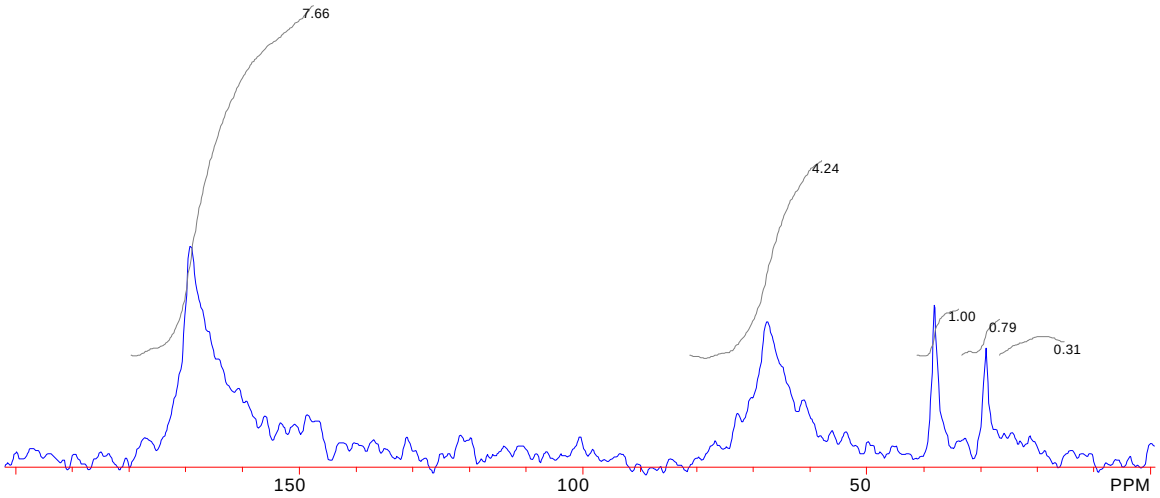
8/9/01												
SYS 2 @ 5^0 C.												
Location	**COD**	**SS**	**VSS**	**VSS/SS**	**NO_3-N**	**PO_4-P**	**Ac**	**NH_4-N**	**PHB**	**PHV**	**PHA**	**Glycogen**
	mg/L	**mg/L**	**mg/L**		**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Synt. Feed	511				0	0	449	35.4				
PO4-P Feed					0	2498	0					
Comb. Inf.	484				0	131	425	33.6				
Anaerobic 1	189	4579	2689	0.59	0	221	122	24.8	177	18	195	146
Anaerobic 2	152	4492	2679	0.60	0	242	100	26	205	19	224	136
Anoxic 1	42	7522	4346	0.58	0	192	0	15.2	201	11	212	300
Anoxic 2	32	7409	4300	0.58	0	210	0	16.3	223	9	232	293
Aerobic 1	30	7589	4246	0.56	1.1	121	0	11.6	149	5	154	320
Aerobic 2	28	7643	4364	0.57	1.7	71	0	9.7	104	7	111	338
Aerobic 3	36	7666	4235	0.55	1.8	40	0	8.9	83	6	89	349
Effluent	32	78	40	0.51	2.1	40	0	8.8				
RAS	30	14033	7783	0.55	1.6	42	0	8.7	110	11	121	606

8/23/01												
SYS 2 @ 5^0 C.												
Location	**COD**	**SS**	**VSS**	**VSS/SS**	**NO_3-N**	**PO_4-P**	**Ac**	**NH_4-N**	**PHB**	**PHV**	**PHA**	**Glycogen**
	mg/L	**mg/L**	**mg/L**		**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Synt. Feed	520				0	0	477	NM				
PO4-P Feed					0	2448	0					
Comb. Inf.	493				0	123	453	NM				
Anaerobic 1	196	4793	2450	0.51	0	214	150	NM	177	12	189	157
Anaerobic 2	168	4628	2392	0.52	0	234	112	NM	211	18	229	148
Anoxic 1	NM	8532	4307	0.50	0	186	0	NM	203	16	219	312
Anoxic 2	NM	8469	4422	0.52	0	202	0	NM	229	7	236	309
Aerobic 1	NM	8727	4418	0.51	1.2	117	0	NM	140	15	155	334
Aerobic 2	NM	8976	4468	0.50	1.9	73	0	NM	90	10	100	341
Aerobic 3	NM	9022	4439	0.49	2.3	41	0	NM	65	6	71	354
Effluent	36	28	13	0.46	2.2	43	0	NM				
RAS	NM	17969	9056	0.50	1.8	44	0	NM	99	7	106	648

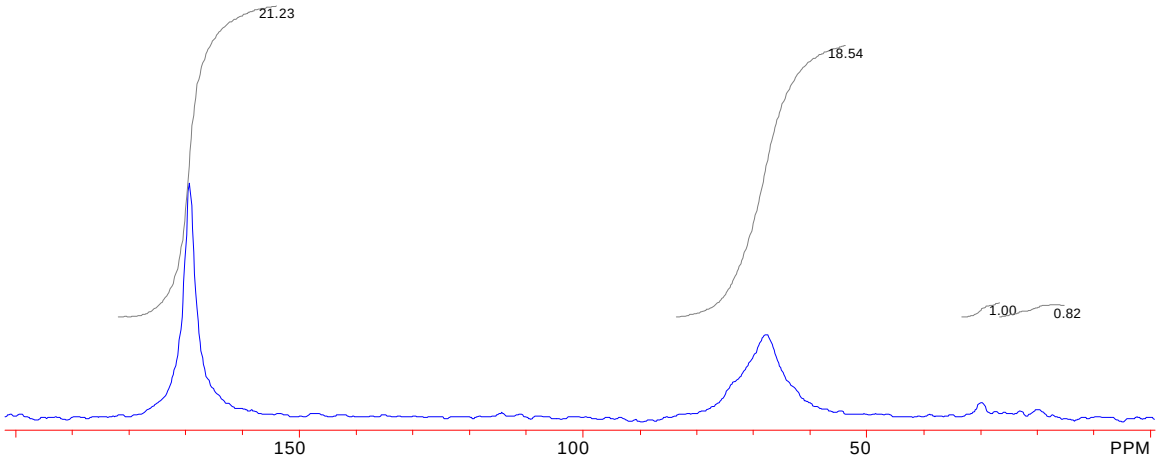
APPENDIX C: NMR SPECTRA OBTAINED FOR THE 20°C AND 5°C EBPR METABOLISM TESTS (CHAPTER III)



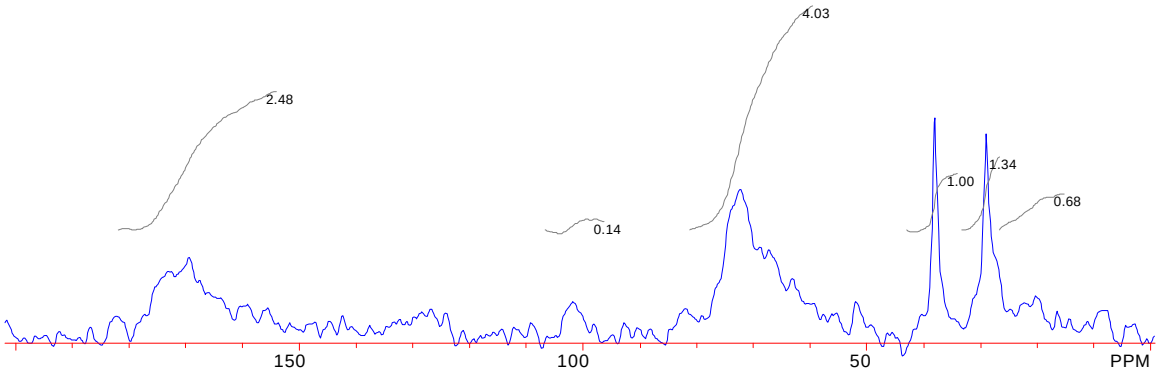
C*-1 ; t = 0



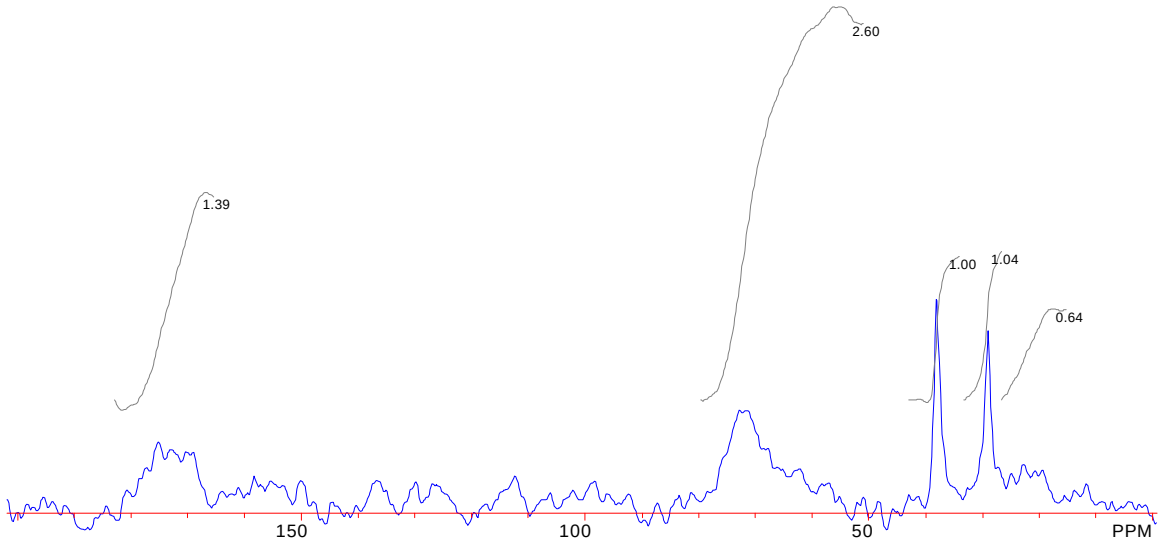
C*-1 ; t = 2 hr



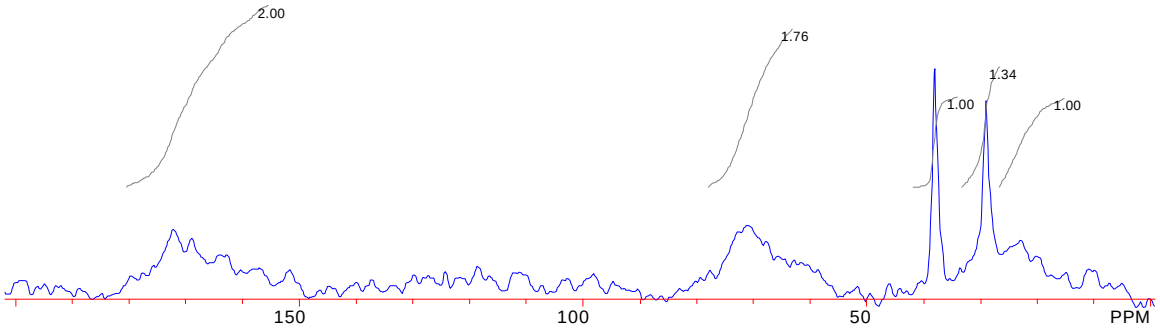
C*-1 ; t = 4 hr



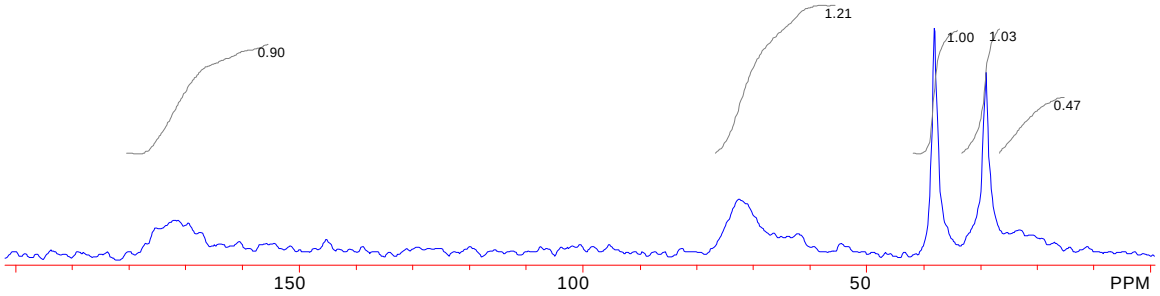
C*-1 ; t = 6 hr



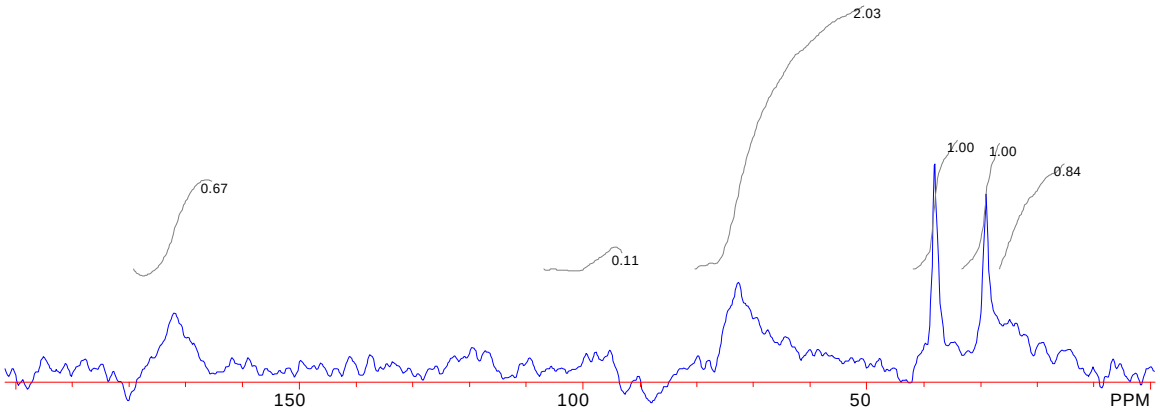
C*-1 ; t = 0 hr (beginning of second cycle)



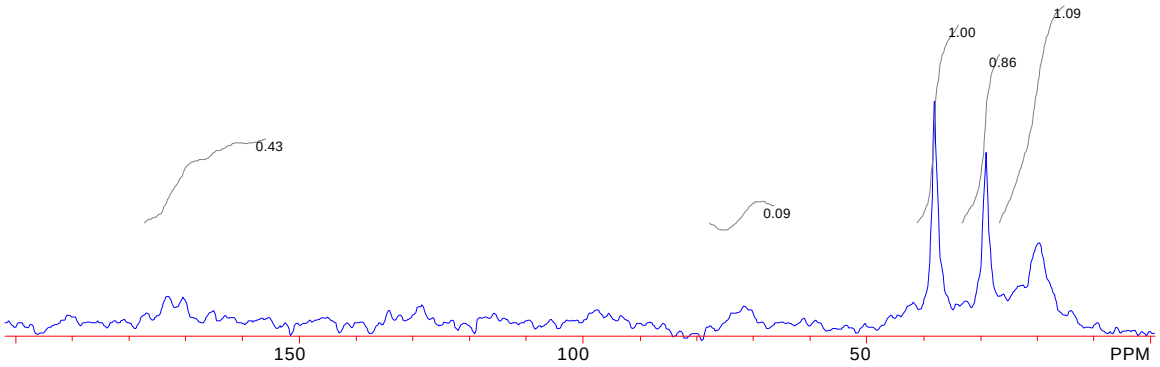
C*-1 ; t = 2 hr



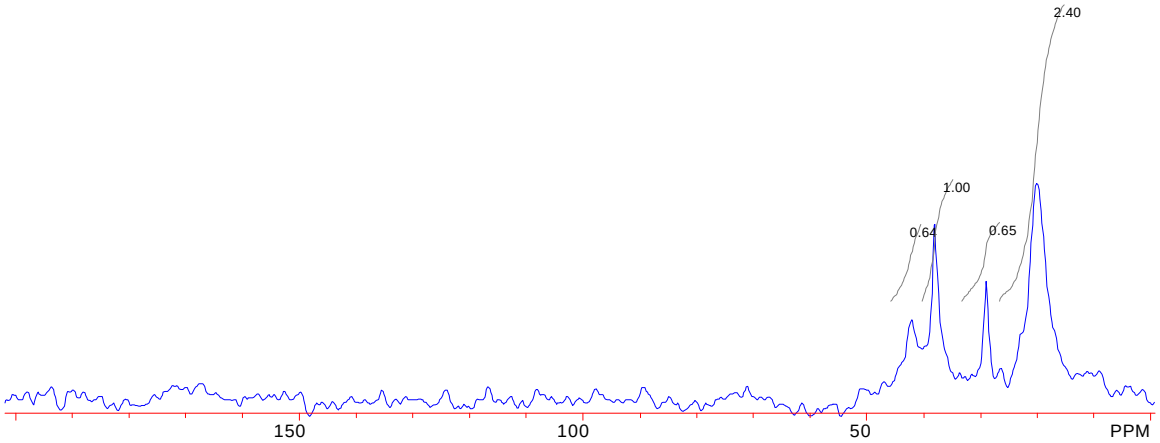
C*-1 ; t = 4 hr



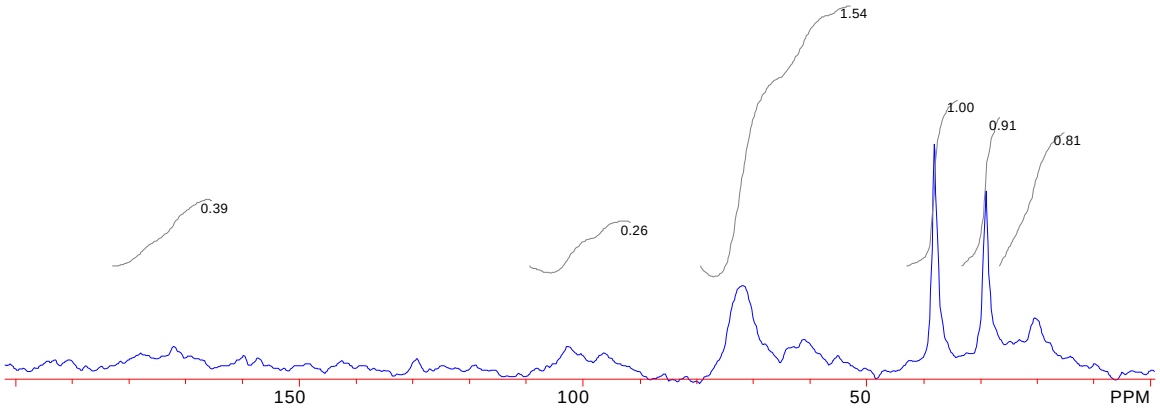
C*-1 ; t = 6 hr



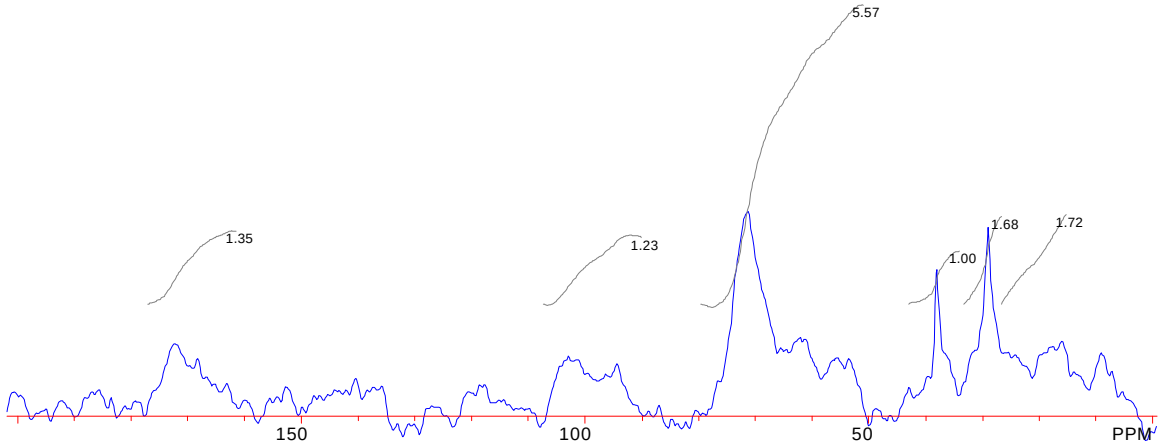
C*-2 ; t = 0



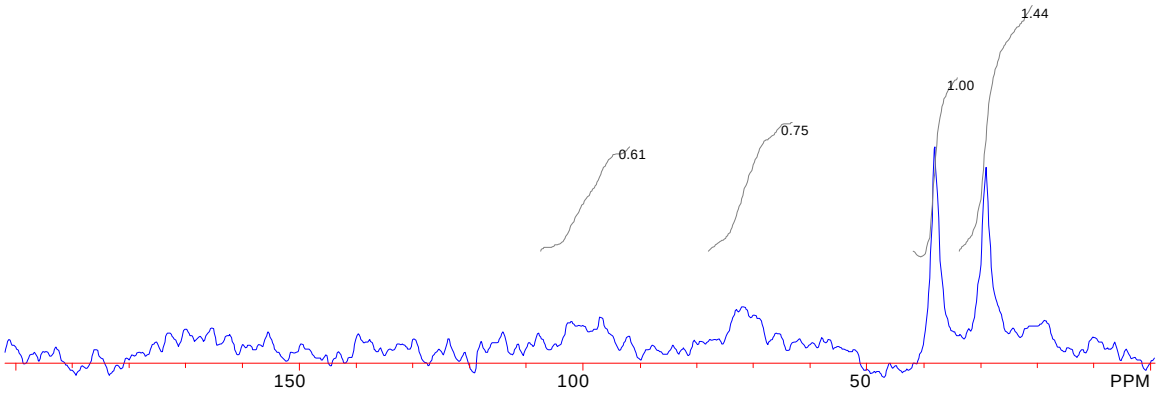
C*-2 ; t = 2 hr



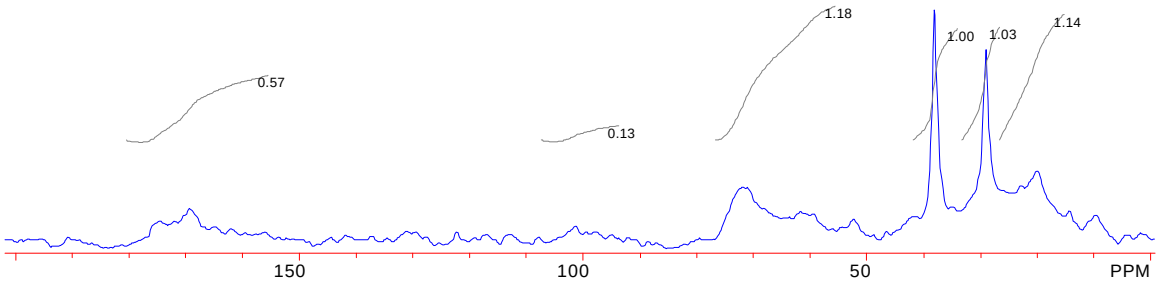
C*-2 ; t = 4 hr



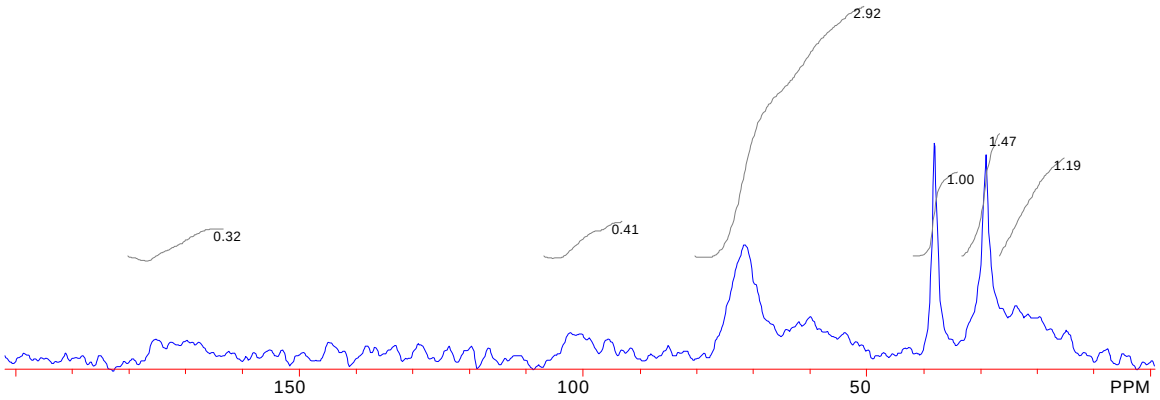
C*-2 ; t = 6 hr



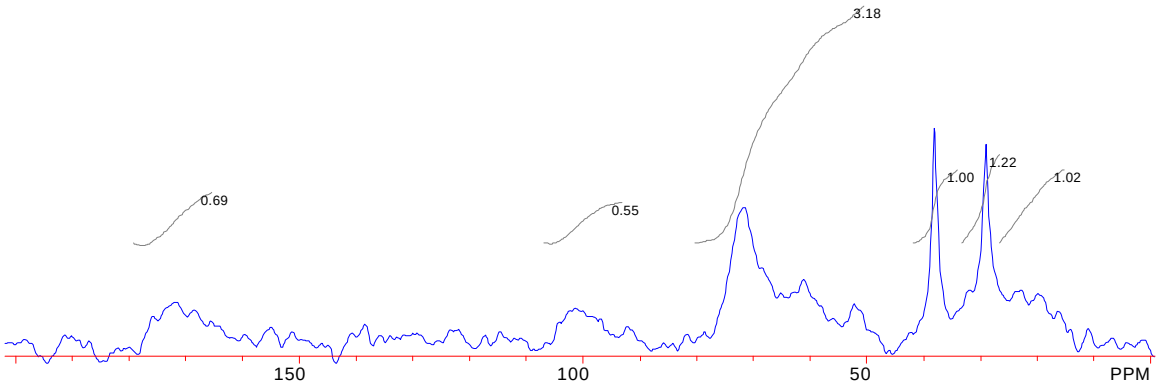
C*-2 ; t = 0 (beginning of the second cycle)



C*-2 ; t = 2 hr

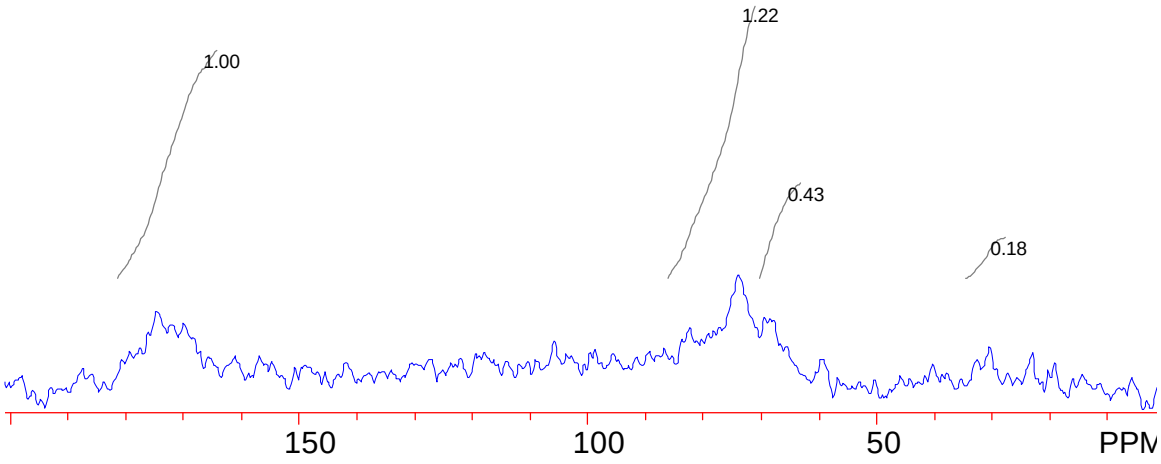


C*-2 ; t = 4 hr

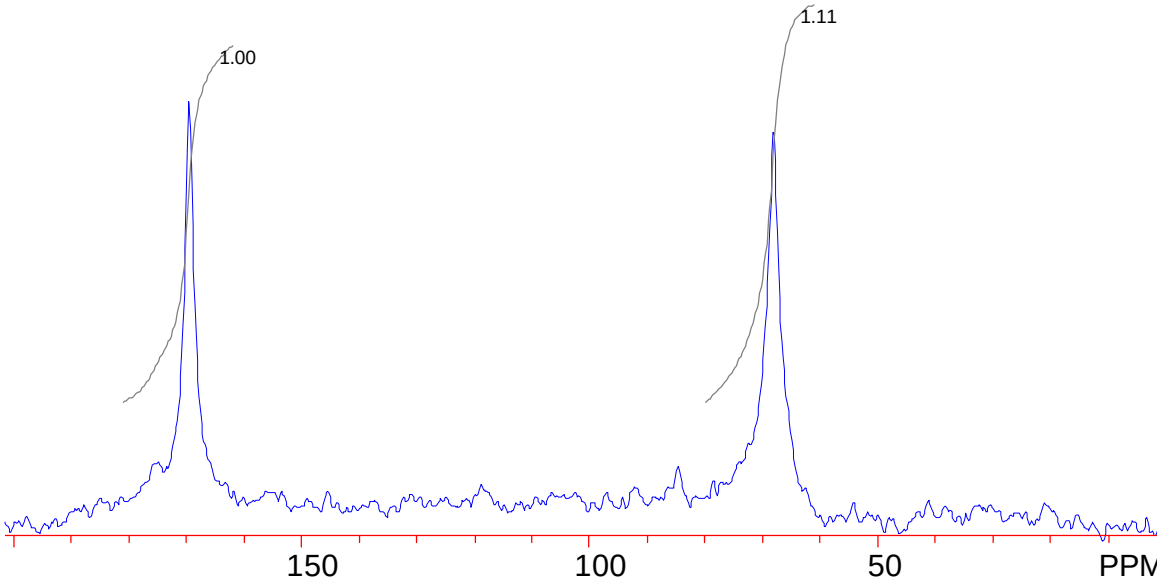


C*-2 ; t = 6 hr

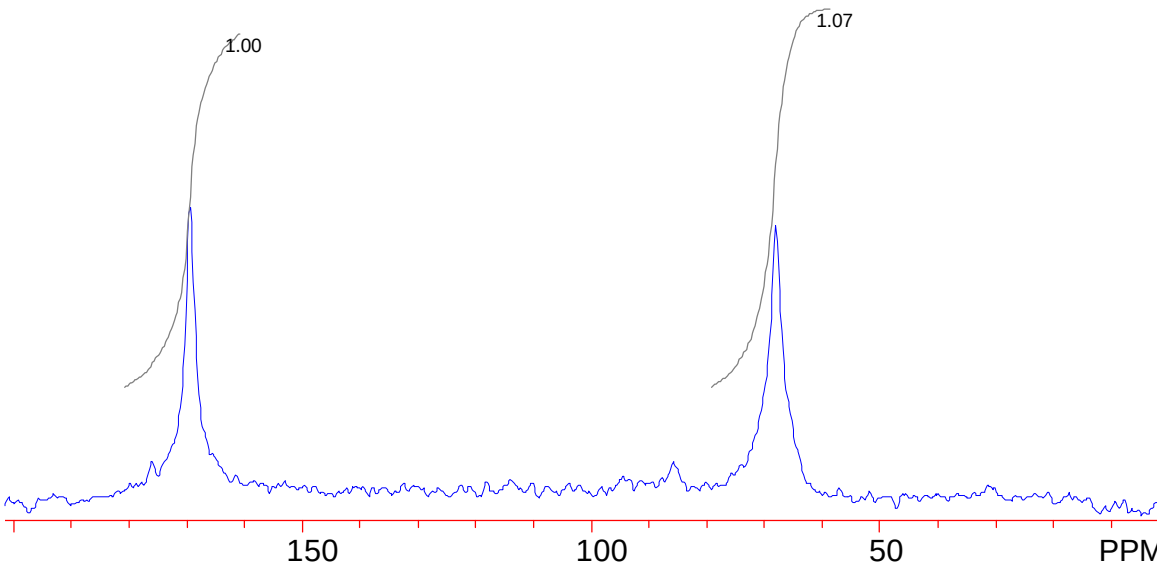
COLD TEST



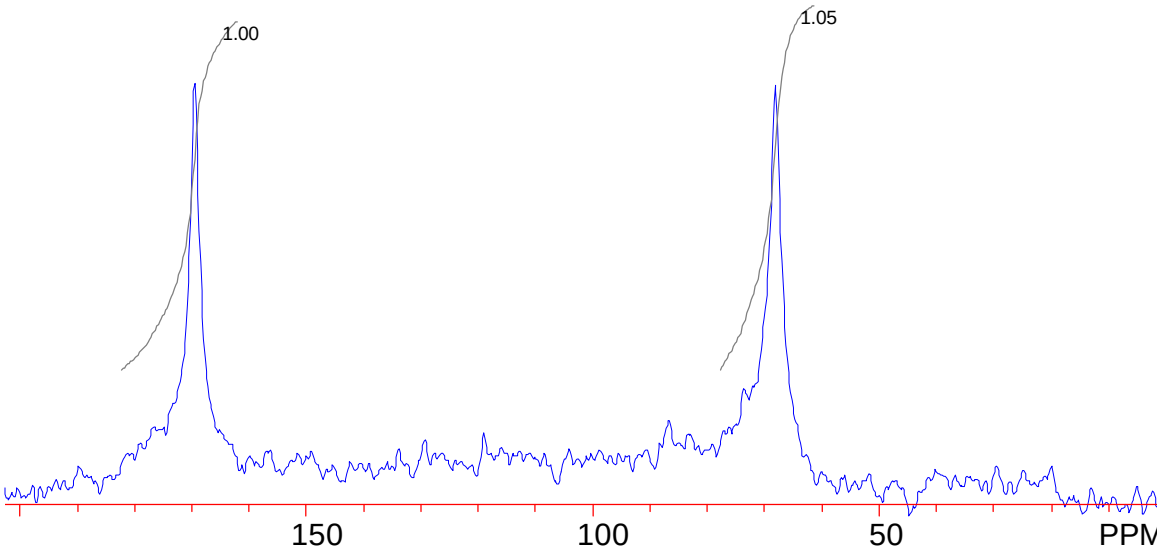
C*-1 ; t = 0



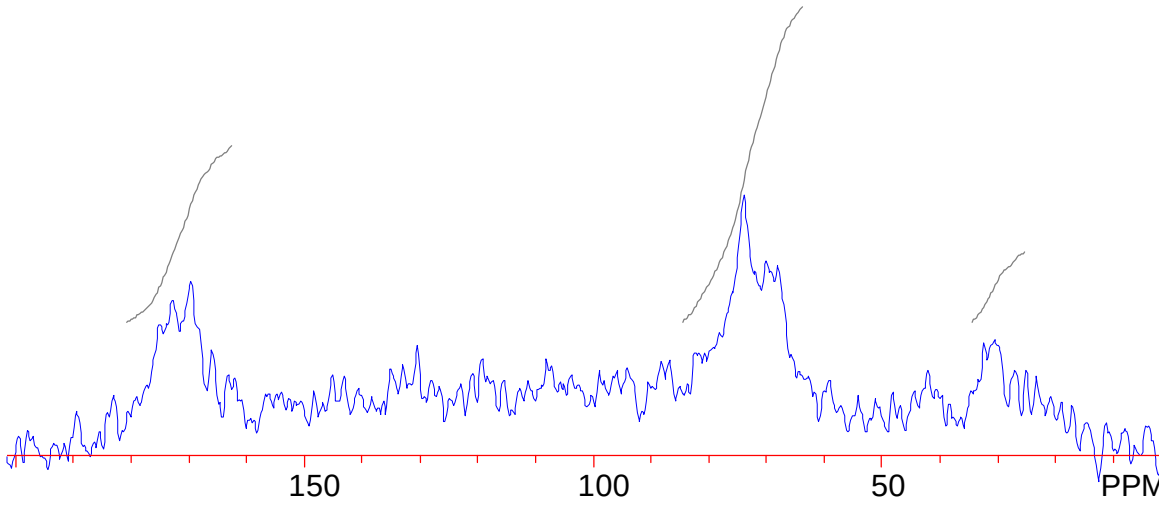
C*-1 ; t = 3.5 hr



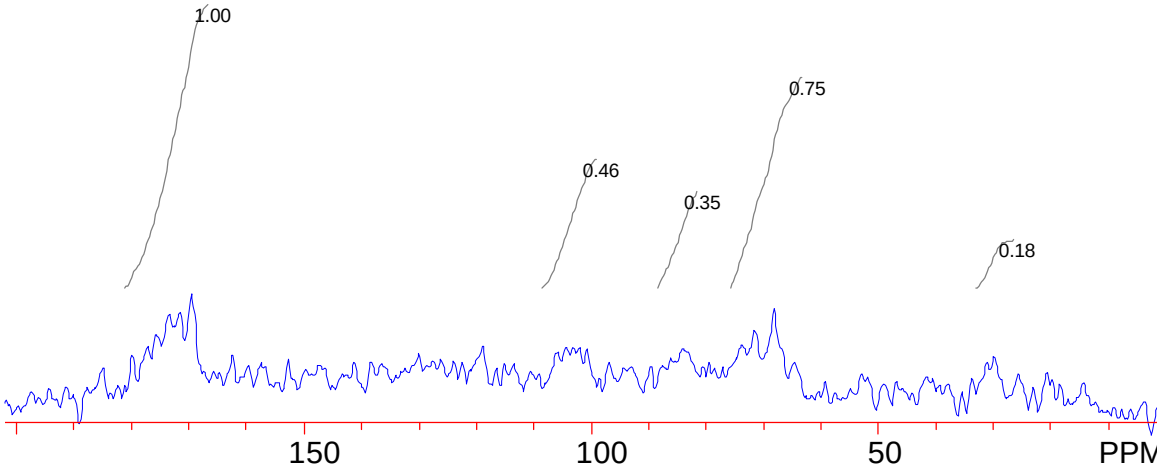
C*-1 ; t = 7 hr



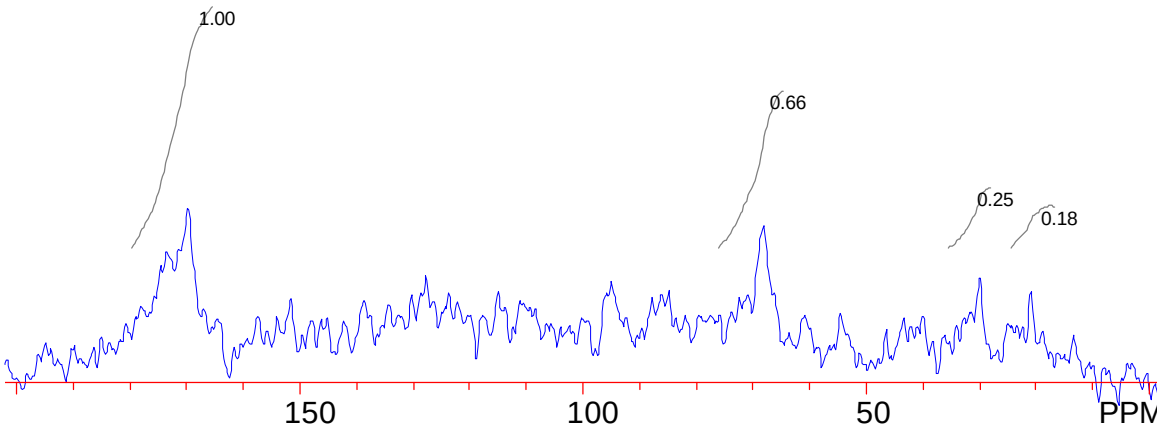
C*-1 ; t = 9 hr



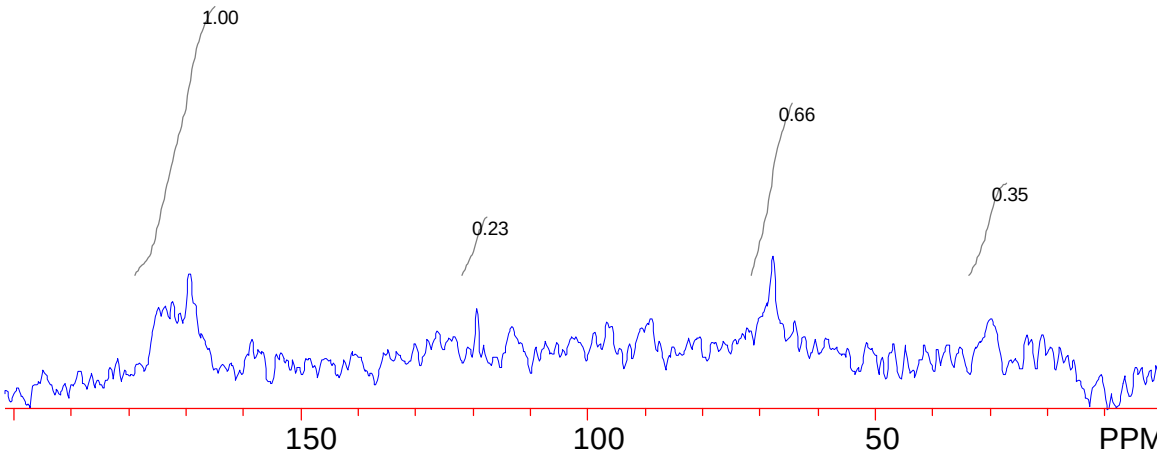
C*-1 ; t = 13 hr



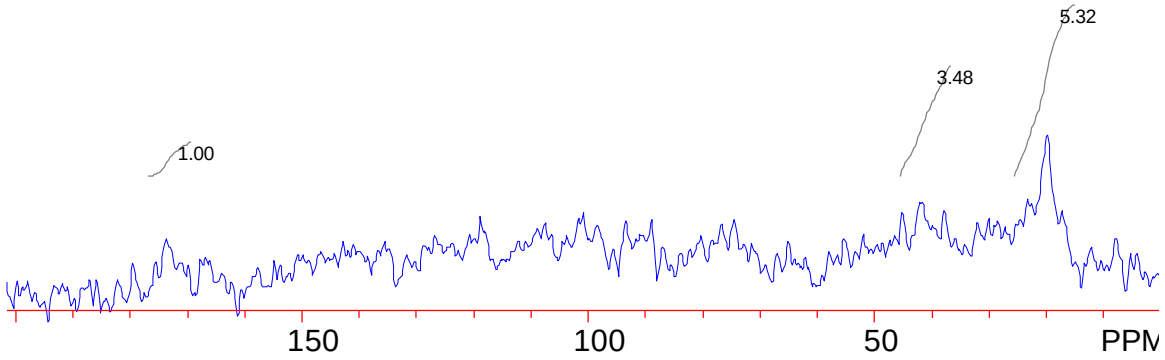
C*-1 ; t = 24 hr



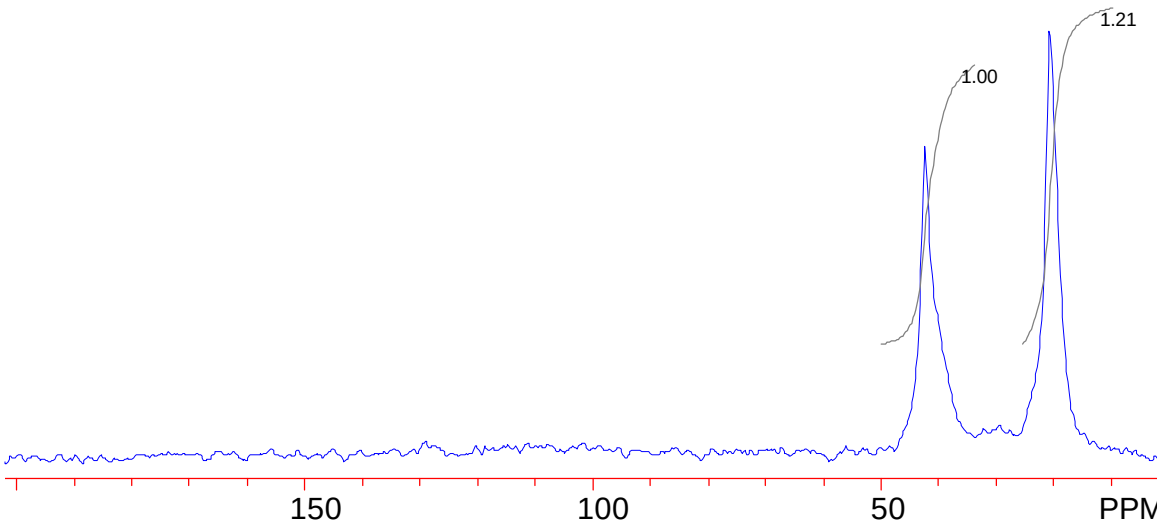
C*-1 ; t = 9.5 hr (second cycle)



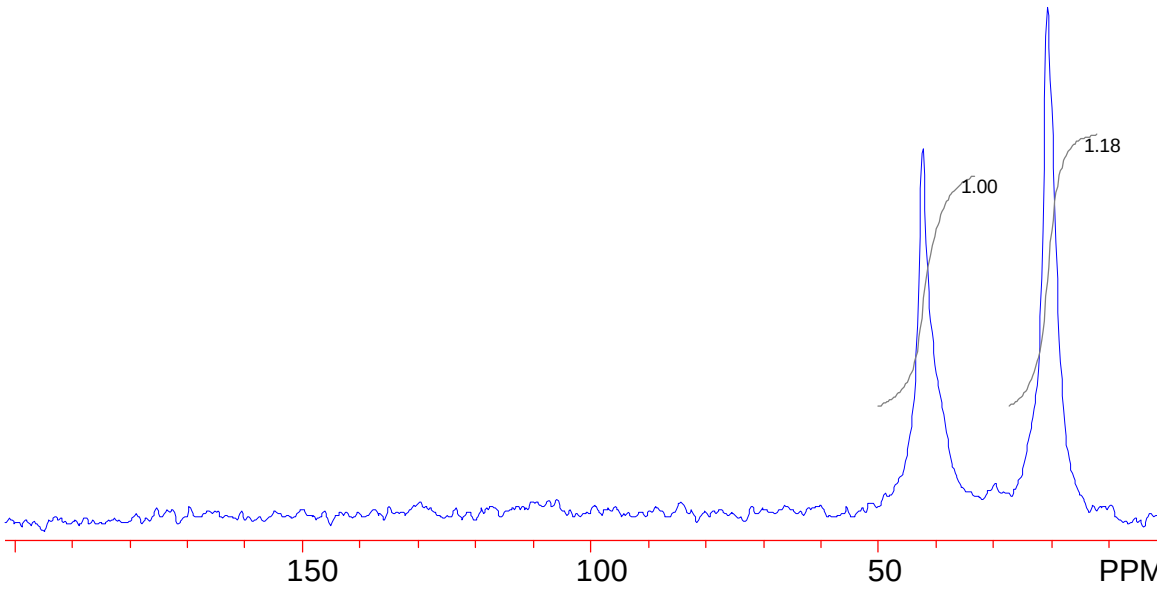
C*-1 ; t = 24 hr



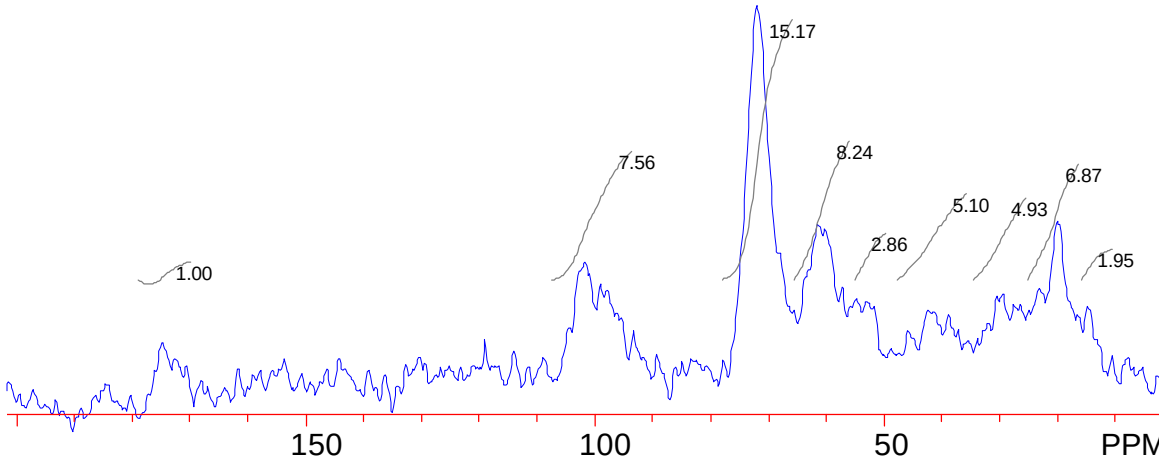
C*-2 ; t = 0



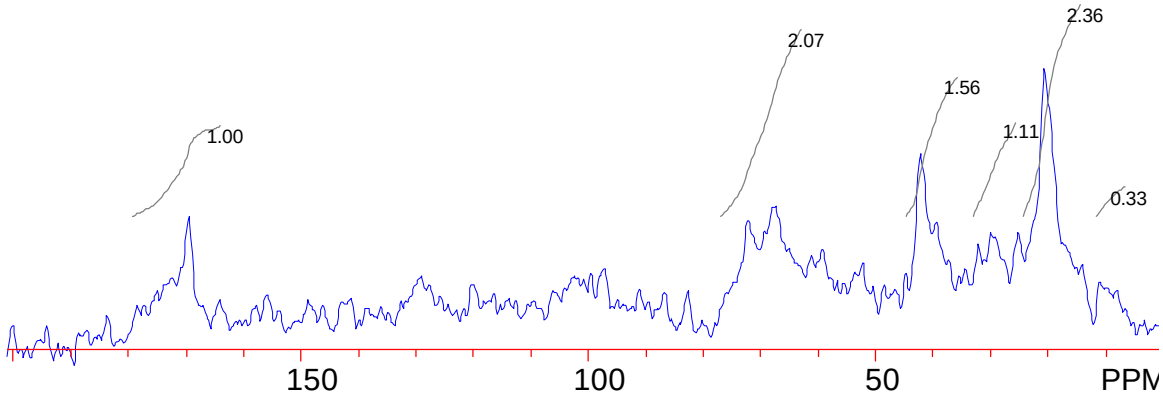
C*-2 ; t = 3.5 hr



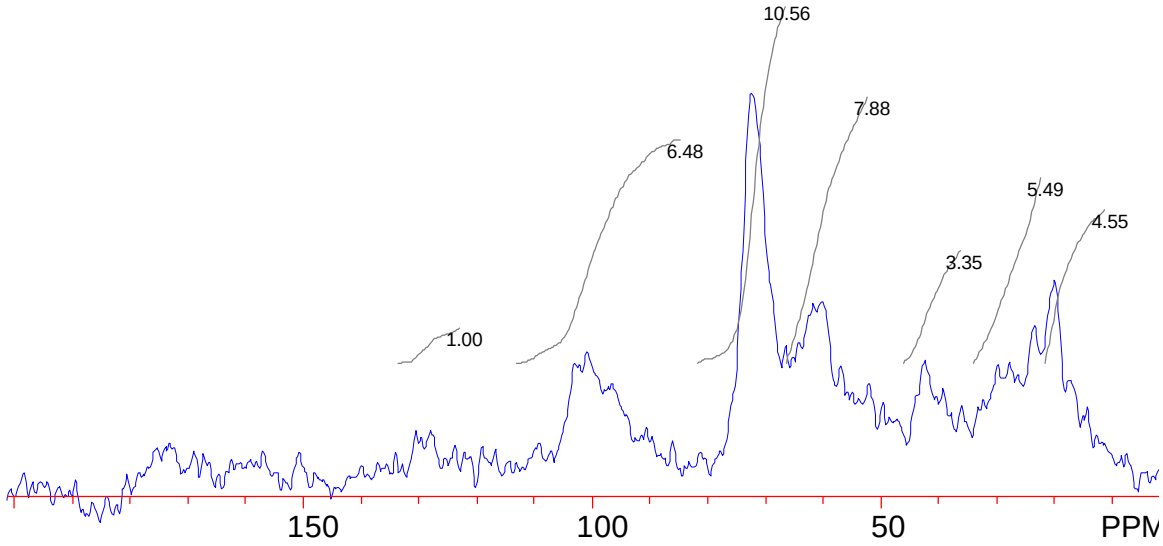
C*-2 ; t = 7 hr



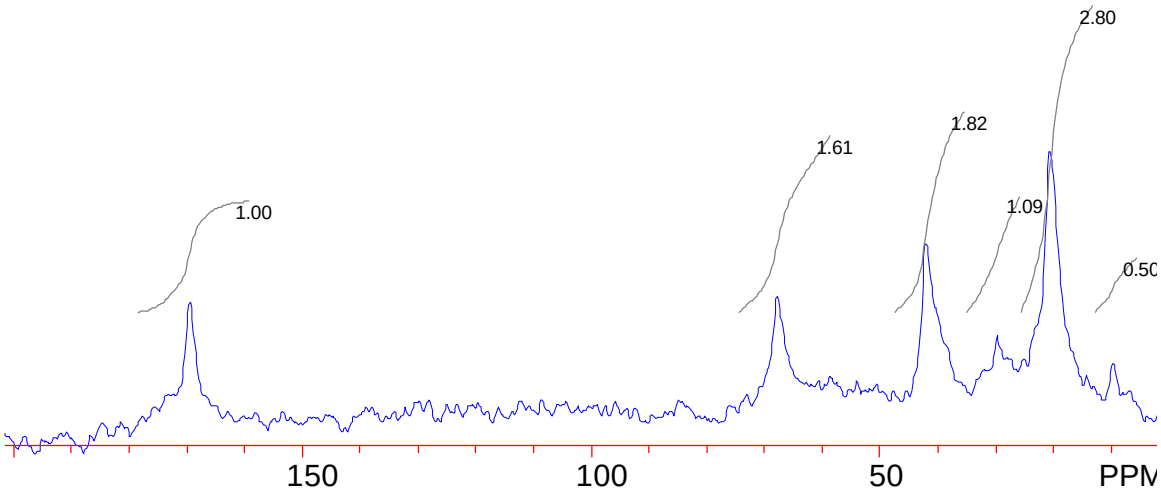
C*-2 ; t = 9 hr



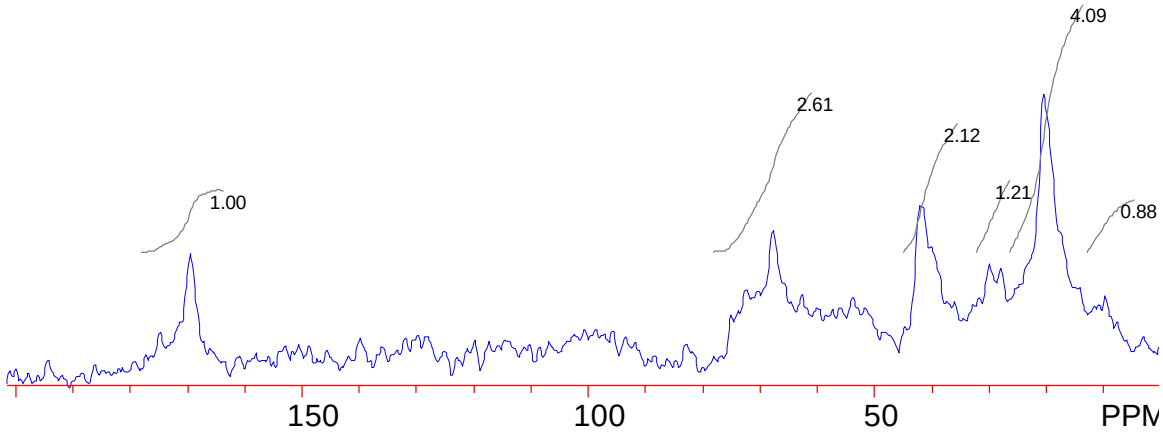
C*-2 ; t = 13 hr



C*-2 ; t = 24 hr



C*-2 ; t = 9.5 hr (second cycle)



C*-2 ; t = 24 hr

ZEYNEP KISOGLU ERDAL

VITA

Zeynep Kisoglu Erdal was born in Kars, Turkey. She received a Bachelor of Science degree in Environmental Engineering from Middle East Technical University, Ankara in 1991. While continuing her graduate education at the same university, she won an overseas graduate program scholarship. She attended the Ohio State University between 1994 and 1996, and received a Masters of Science Degree in Environmental Engineering in the Spring semester of the year 1996. She was then accepted for the doctoral program at the Virginia Tech Civil and Environmental Engineering Department in the Fall of 1996. She completed her Ph.D. studies at the same department in the Spring semester of 2002.