表１　管理値のまとめ

水温	0～10 ℃	10～20 ℃	20 ℃～
紫外線吸光度（250 nm、50mm）	0.083	0.067	0.056

表２　H28 年度ハロ酢酸低減化対策実施状況

	塩素注入点（前または中間）			粉末活性炭
	着水井	フロック形成池	沈澱池末端	(mg/L)
4/1～5/15	○	○		―
5/16～6/5		○		―
6/6～7/28		○		3
7/29～9/4		○		4
9/5～10/11			○	4
10/12～		○		4

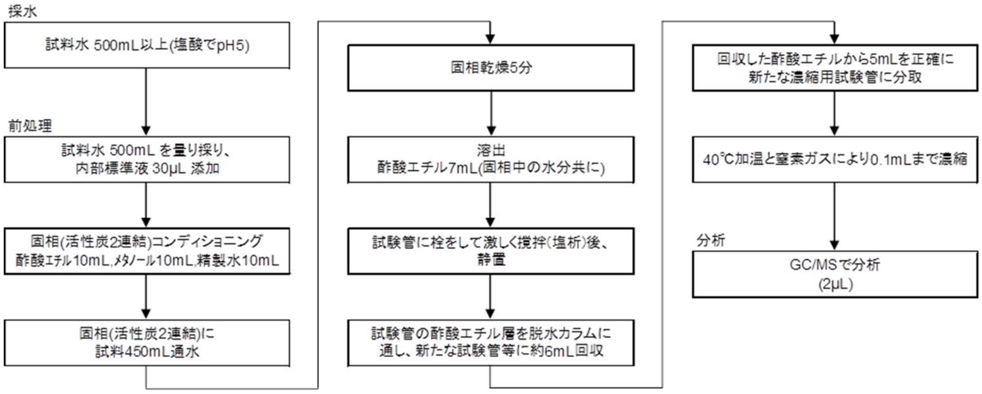

図１　ハロアセトアミドの分析フロー

表３　ハロアセトアミド GC/MS 分析条件

測定装置	GC：Agilent製 7890A MS：Agilent製 5975C	ﾓﾆﾀｰｲｵﾝ(m/z)	定量	確認	
		1,2-ｼﾞﾌﾞﾛﾓﾌﾟﾛﾊﾟﾝ	121	123	41
分離カラム	GL Sciences製 InertCap 5MS（30m×0.25mm、1.00μm）	ｸﾛﾛｱｾﾄｱﾐﾄﾞ	93	44	
注入方法	スプリットレス	ﾌﾞﾛﾓｱｾﾄｱﾐﾄﾞ	137	139	44
カラム温度	35℃（3分）→10℃／分→190℃→30℃／分→290℃（10分）	ｼﾞｸﾛﾛｱｾﾄｱﾐﾄﾞ	127	44	
キャリヤーガス	He 1.5mL/min	ﾌﾞﾛﾓｸﾛﾛｱｾﾄｱﾐﾄﾞ	173	44	
注入口温度	250℃	ﾄﾘｸﾛﾛｱｾﾄｱﾐﾄﾞ	82	98	44
イオン源温度	230℃	ｼﾞﾌﾞﾛﾓｱｾﾄｱﾐﾄﾞ	217	174	44

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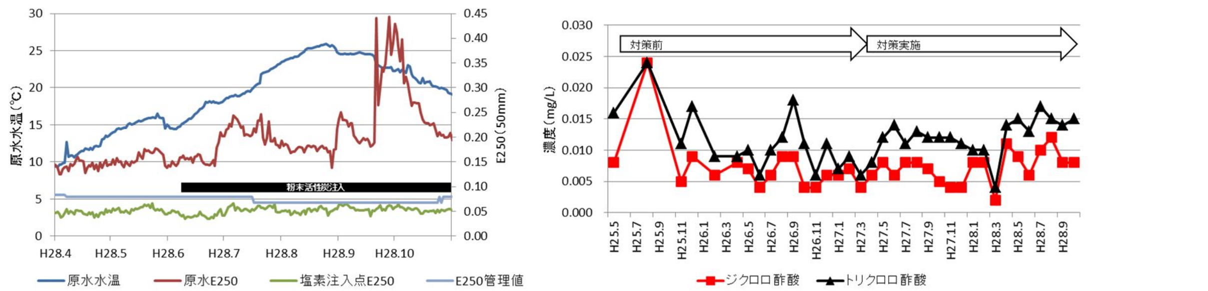


図 2 塩素注入点と原水吸光度に基づいたハロ酢酸制御（左：E250 管理状況，右：ハロ酢酸月最大値のまとめ）

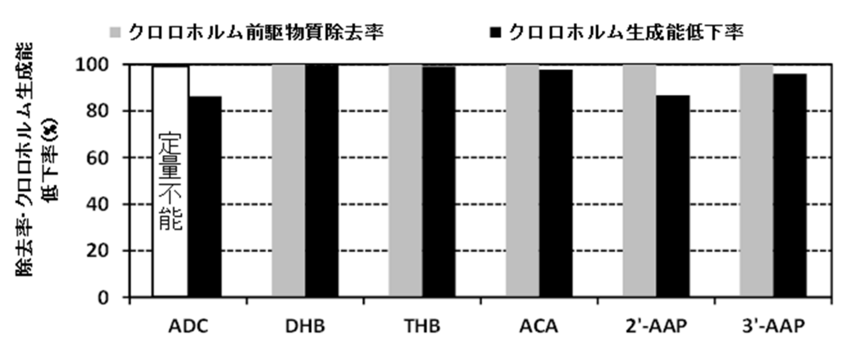


図 3 クロロホルム前駆物質の中オゾン処理性調査結果

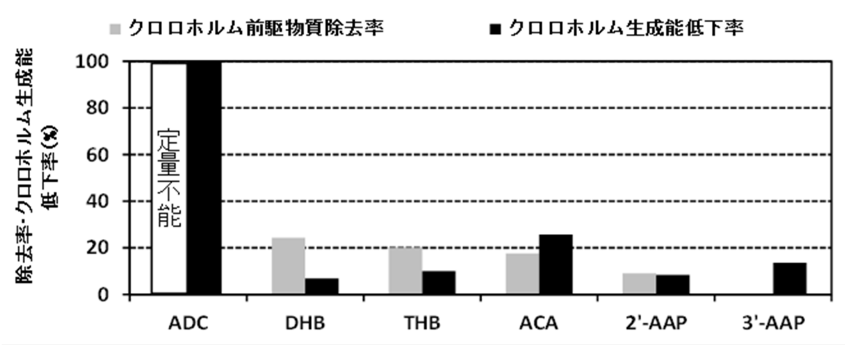


図 4　クロロホルム前駆物質の急速砂ろ過処理性調査結果

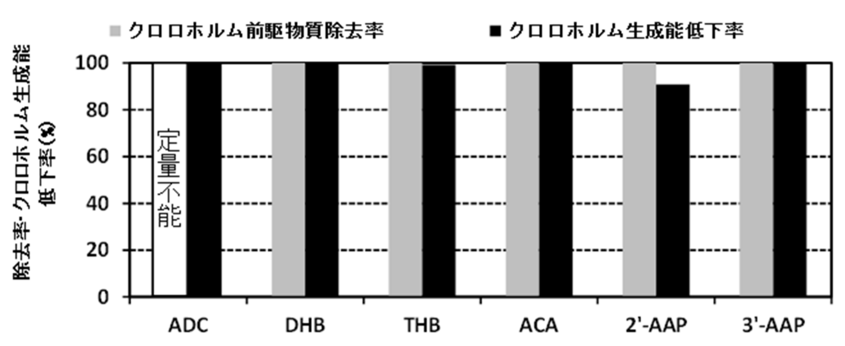


図 5　クロロホルム前駆物質の GAC 処理性調査結果

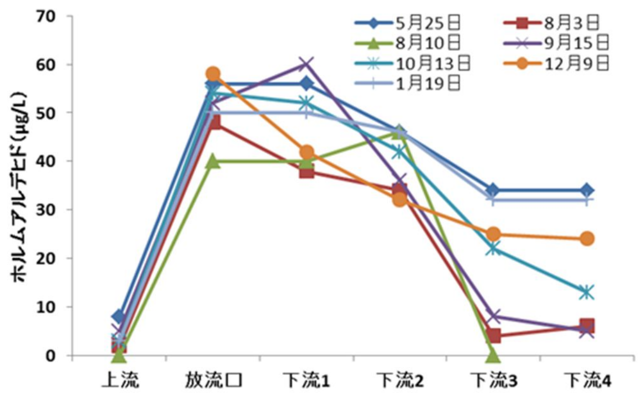


図 6　西高瀬川におけるホルムアルデヒドの挙動

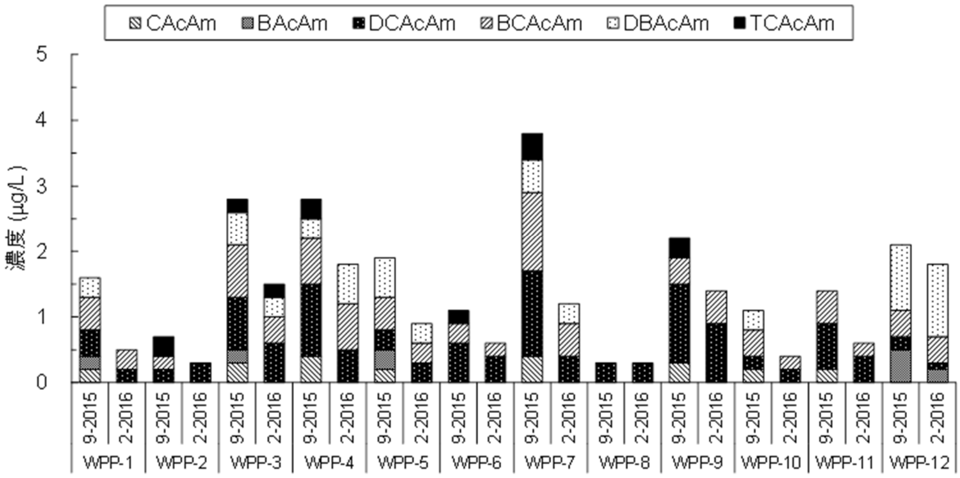


図 7 全国 12 浄水場の水道水中の HAcAms 濃度

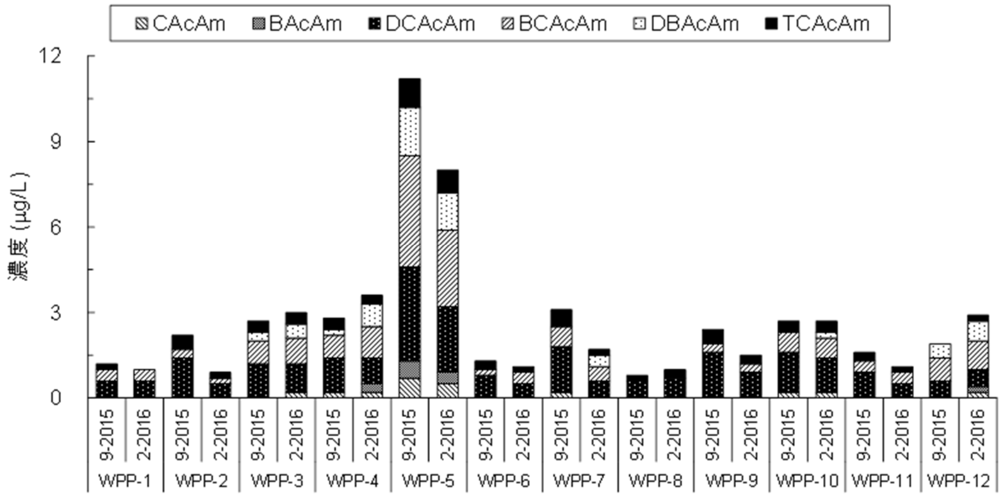


図 8　全国 12 浄水場の原水の HAcAms 生成能

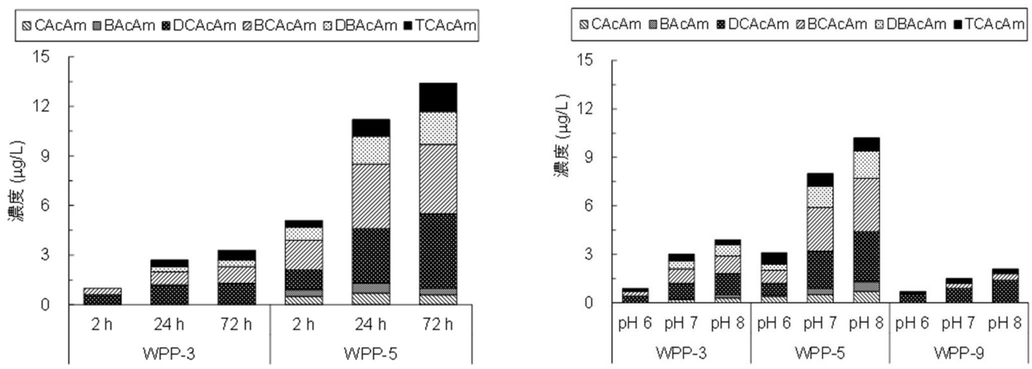


図 9　原水の HAcAms 生成能におよぼす塩素処理時間（左）と pH(右)の影響

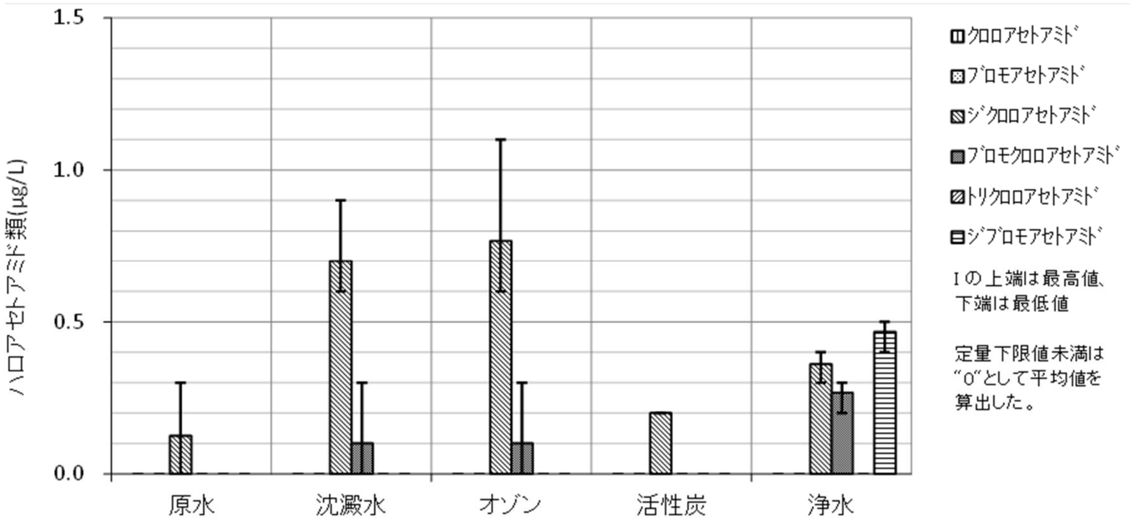


図 10　浄水処理過程における検出状況(平均値)

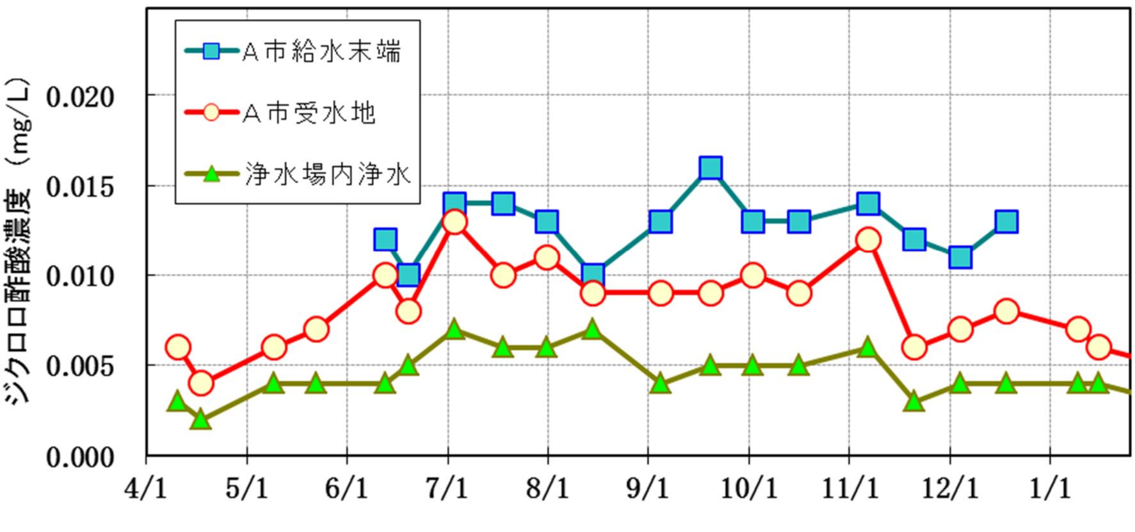


図 11　浄水場内浄水等のジクロロ酢酸濃度の推移

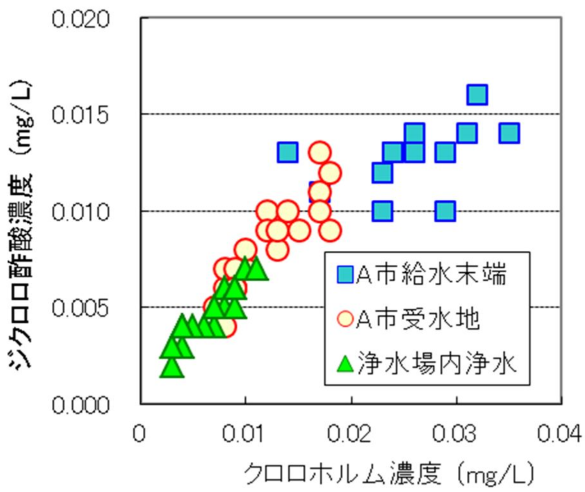


図 12　ジクロロ酢酸とクロロホルムの相関

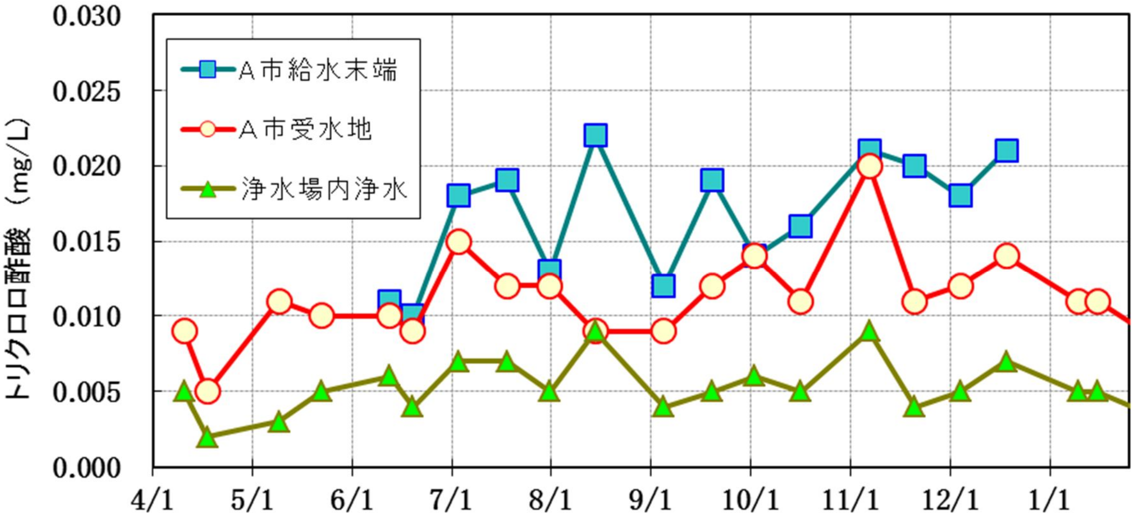


図 13　浄水場内浄水等のトリクロロ酢酸の推移

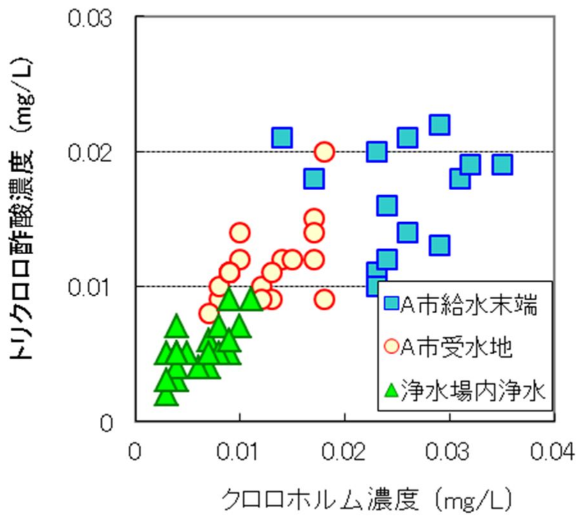


図 14　トリクロロ酢酸とクロロホルムの相関

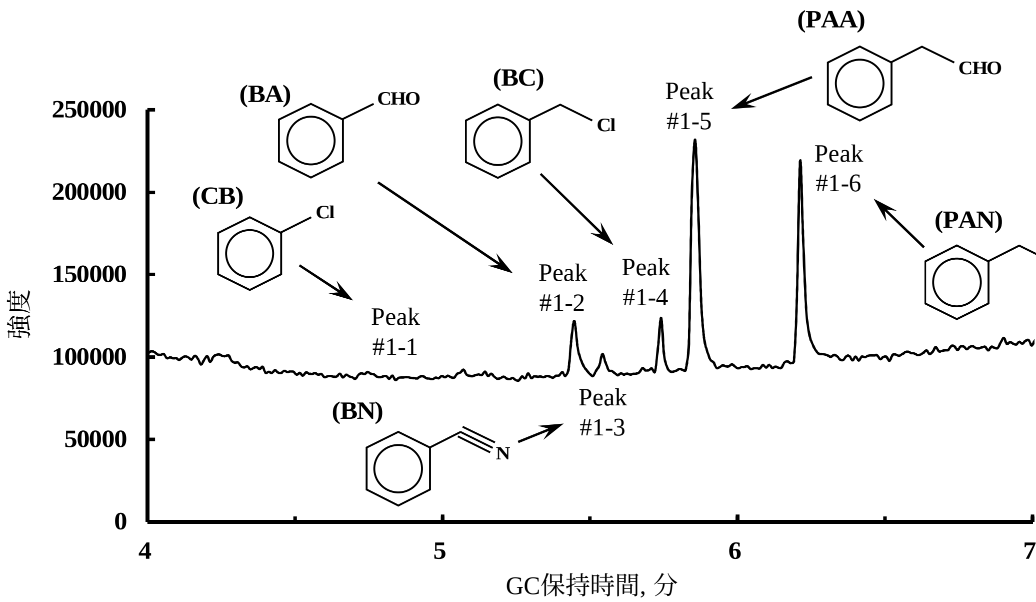


図 15　フェニルアラニン塩素処理溶液のパージ＆トラップ―GC/MS トータルイオンクロマトグラム
CB,クロロベンゼン;BA,ベンズアルデヒド;BN,ベンゾニトリル;BC,塩化ベンジル;PAA,フェニルアセトアルデヒド;PAN,フェニルアセトニトリル

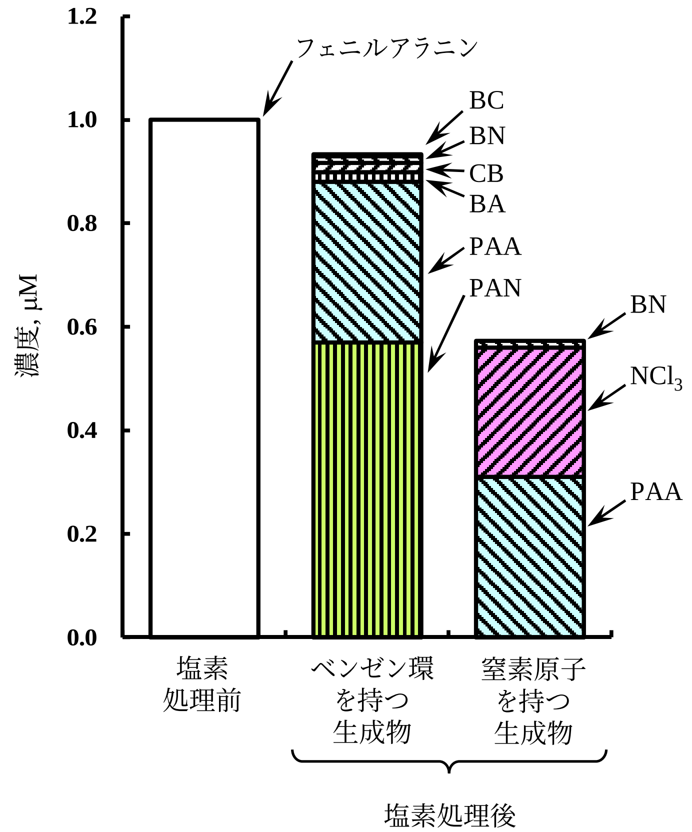


図 16　フェニルアラニン塩素処理溶液での生成物　PAA,フェニルアセトアルデヒド;PAN,フェニルアセトニトリル;NCL_3,トリクロラミン;BA,ベンズアルデヒド;CB,クロロベンゼン;BN,ベンゾニトリル;BC,塩化ベンジル

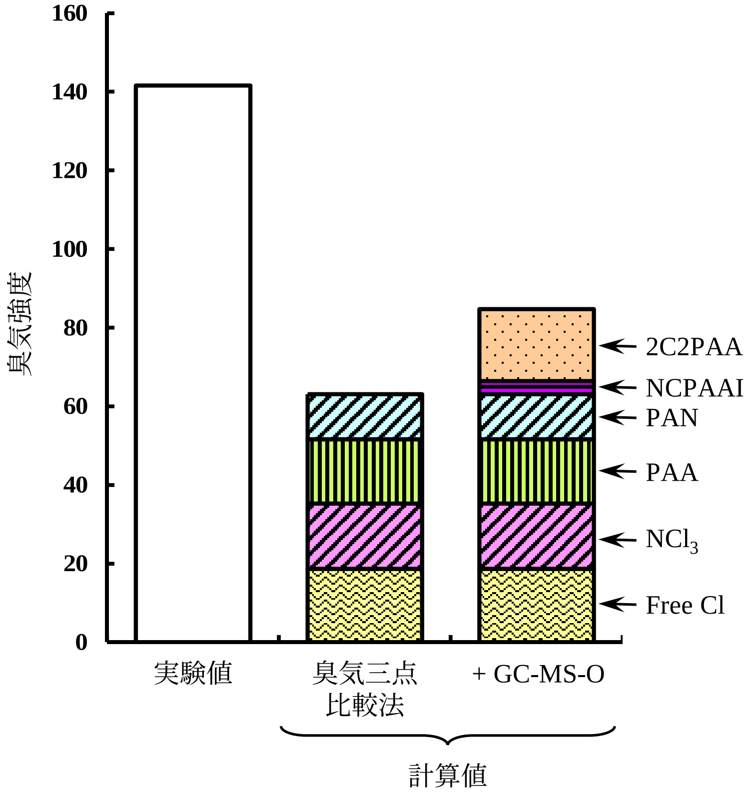


図 17　フェニルアラニン塩素処理溶液の臭気強度の実験値と計算値の比較　2C2PAA,2-クロロ-2-フェニルアセトアルデヒド;NCPAAI,N-クロロフェニルアセトアルドイミン;PAN,フェニルアセトニトリル;PAA,フェニルアセトアルデヒド;NCL_3,トリクロラミン;free Cl,遊離塩素

表 5　三点比較法により評価した標準品が入手可能な分解生成物の臭気閾値とそれらのフェニルアラニン塩素処理溶液中での濃度

生成物など	検出濃度 µM	本研究での臭気閾値 µM	µg/L	既存文献における臭気閾値 µg/L
フェニルアセトアルデヒド (PAA)	0.57	0.035	4.2	4[1–3], 1200[4]
フェニルアセトニトリル (PAN)	0.31	0.027	3.2	30[4]
トリクロラミン	0.25	0.015	3.1 (µg-Cl_2/L)	20 (µg-Cl_2/L)[5]
ベンズアルデヒド (BA)	0.019	0.79	84	350[3], 2000[6], 4600[1]
クロロベンゼン (CB)	0.018	0.31	35	50[7]
ベンゾニトリル (BN)	0.013	0.26	27	
塩化ベンジル (BC)	0.0034	0.025	3.1	12[7]
遊離塩素	14	0.75	53 (µg-Cl_2/L)	50 (µg-Cl_2/L)[8]

[1] Noguerol-Pato et al. (2013); [2] Eduardo et al. (2010); [3] Buttery et al. (1988); [4] Freuze et al. (2005); [5] Kransner and Barrett (1984); [6] Noguerol-Pato et al. (2011); [7] Amoore and Hautala (1983); [8] Piriou et al. (2004).

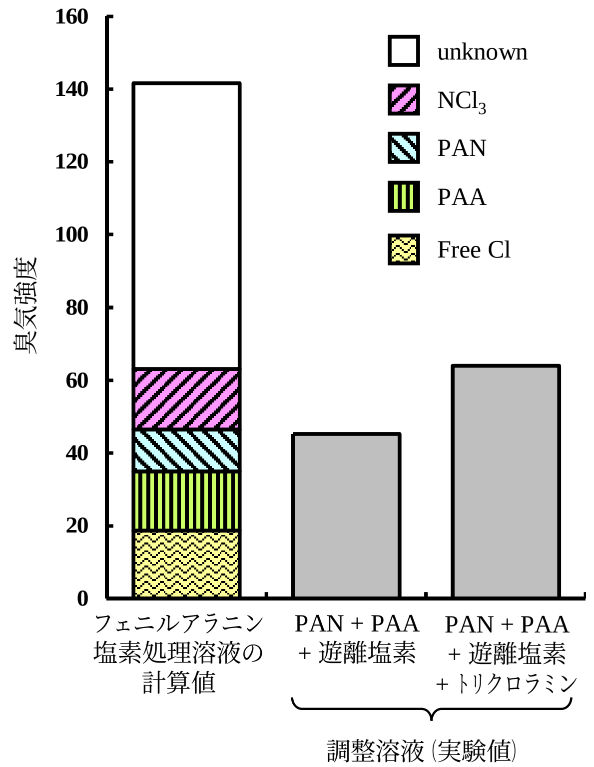


図 18　フェニルアラニン塩素処理溶液と同濃度の生成物（標準品）を含む調整溶液の臭気強度（臭気三点比較法による実験値）と計算値の比較　PAN,フェニルアセトニトリル;PAA,フェニルアセトアルデヒド;NCl_3,トリクロラミン;free Cl,遊離塩素

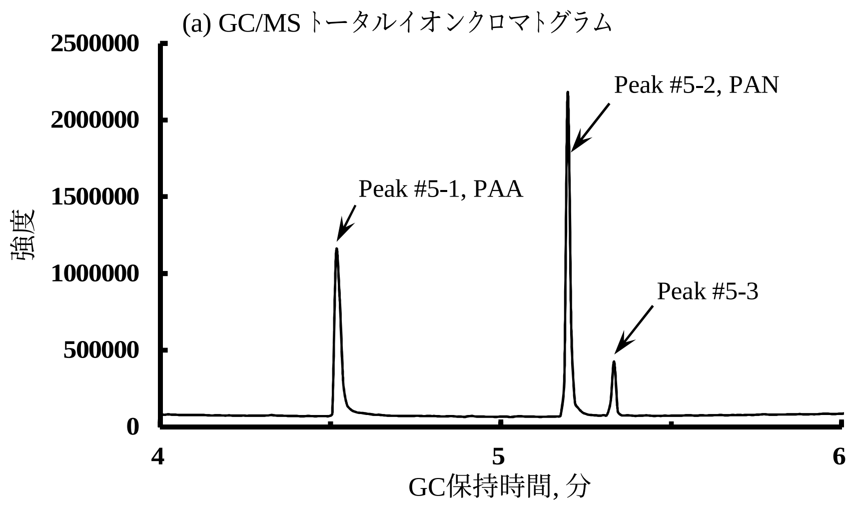


図 19　(a)フェニルアラニン塩素処理溶液をクロロホルムにより溶媒抽出したサンプルの GC/MS トータルイオンクロマトグラム　(b)高濃度 NCPAAI 溶液をクロロホルムにより溶媒抽出したサンプルのオルファクトメトリッククロマトグラム PAA,フェニルアセトアルデヒド; PAN,フェニルアセトニトリル

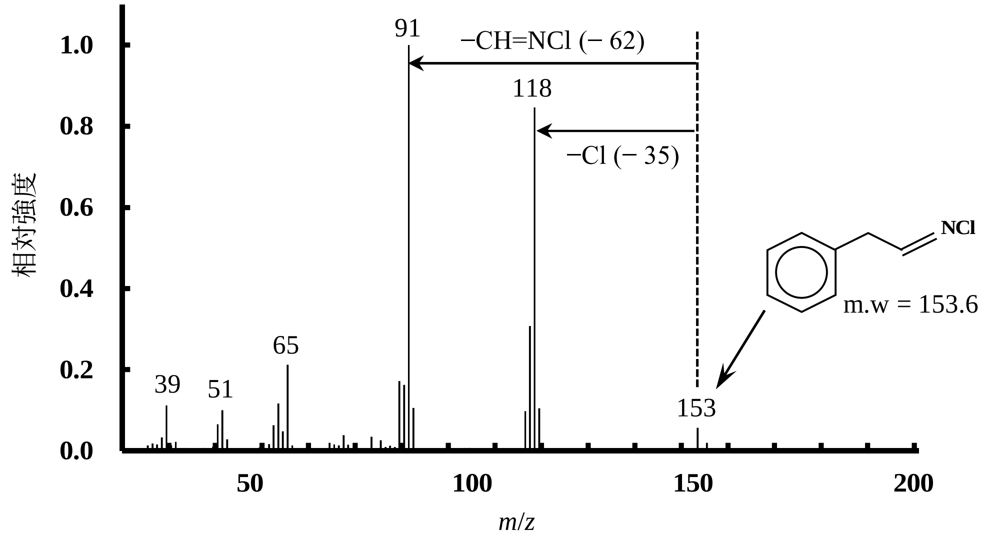


図 20　Peak#5-3 のマススペクトル

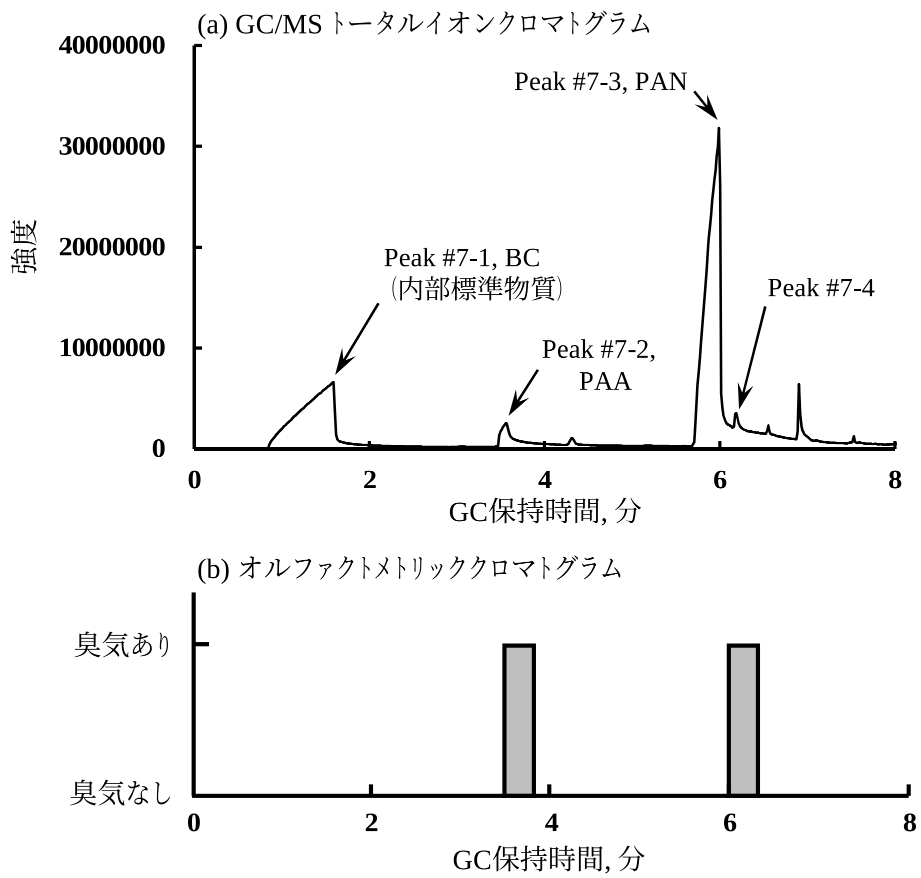


図 21　TP 探索用溶液の(a)GC/MS トータルイオンクロマトグラムと(b)オルファクトメトリッククロマトグラム　BC,塩化ベンジル(内部標準物質);PAA,フェニルアセトアルデヒド; PAN,フェニルアセトニトリル

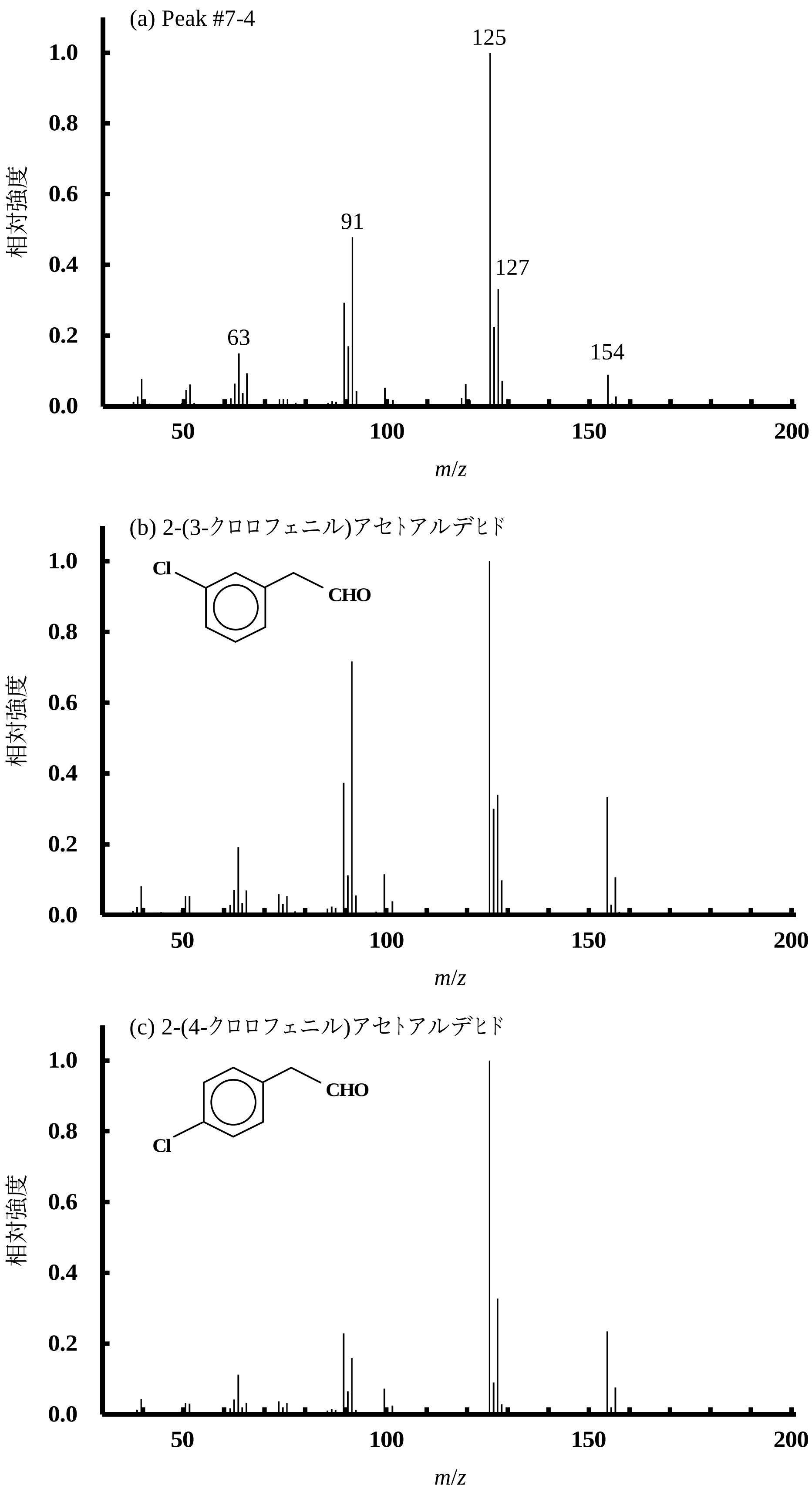
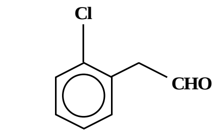
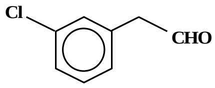
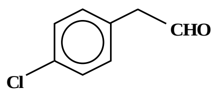
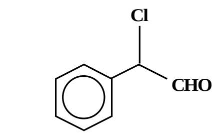


図 22　(a)Peak#7-4(保持時間 6.2 分),(b)2-(3-クロロフェニル)アセトアルデヒド標準品(保持時間 6.7 分),(c) 2-(4-クロロフェニル)アセトアルデヒド標準品(保持時間 6.8 分)のマススペクトルの比較

表 6　Peak#7-4 として検出された生成物の構造の候補 沸点は ChemSpider web (http://www. Chemspider.com/)上での ACD/Labs Predictor と EPISuite による予測値

	沸点, °C	
	ACD/Labs	EPISuite
 (a) 2-(2-クロロフェニル)アセトアルデヒド	235.8 ± 15	232.30
 (b) 2-(3-クロロフェニル)アセトアルデヒド	235.8 ± 15	232.30
 (c) 2-(4-クロロフェニル)アセトアルデヒド	235.8 ± 15	232.30
 (d) 2-クロロ-2-フェニルアセトアルデヒド	219.0 ± 20	220.81

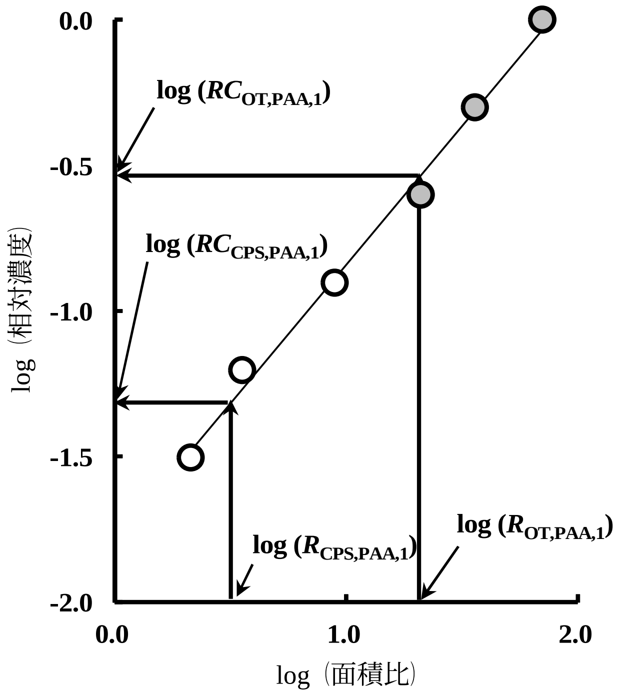


図 23　パネラー#1 に対する溶媒抽出－GC-MS-O 分析における PAA の面積比の常用対数値と相対濃度の常用対数値の関係 灰丸,パネラーが PAA の臭気を感知;白丸。パネルが PAA の臭気を否感知;$R_{CPS,PAA,1}$,フェニルアラニン塩素処理溶液中の PAA の面積比; $R_{OT,PAA,1}$,パネラーが臭気を感知できた最小の PAA の面積比

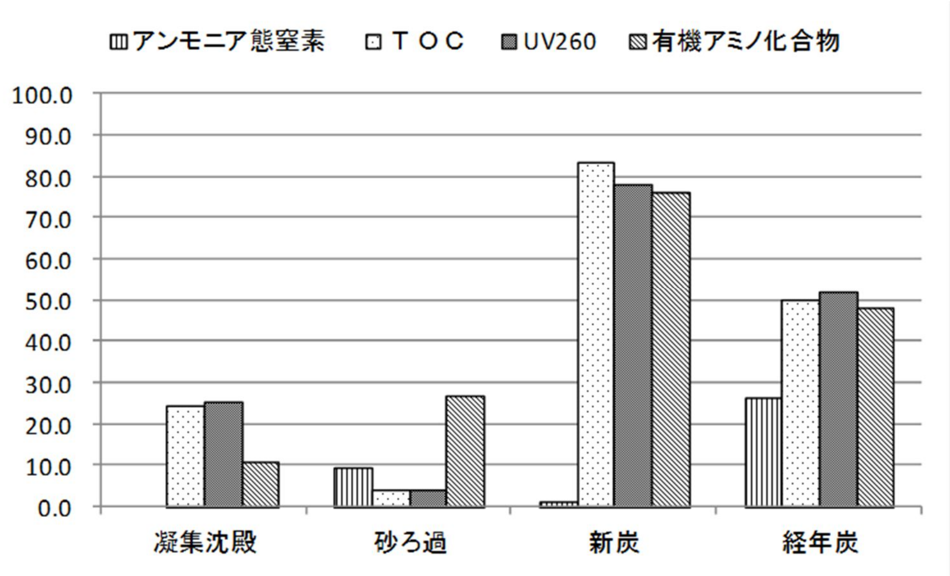


図 24　処理工程における各項目の除去率

表 7　クロラミン生成能

単位：mg/L

試料名	**モノクロラミン**	**ジクロラミン**	**トリクロラミン**
砂ろ過水	0.12	0.50	0.15
新炭処理水	0.02	0.11	0.33
経年炭処理水	0.06	0.24	0.24

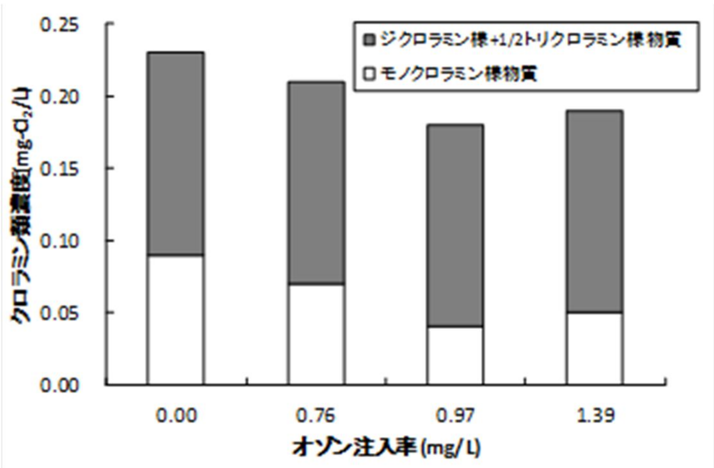


図 25 オゾン処理によるクロラミン類生成状況の変化（大場川）

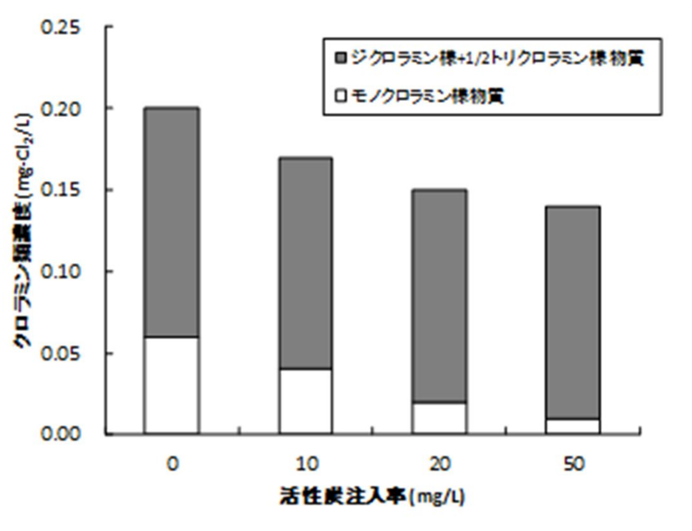


図 26 PAC 処理によるクロラミン類生成状況の変化（対象水：大場川と江戸川の混合水（1：7））

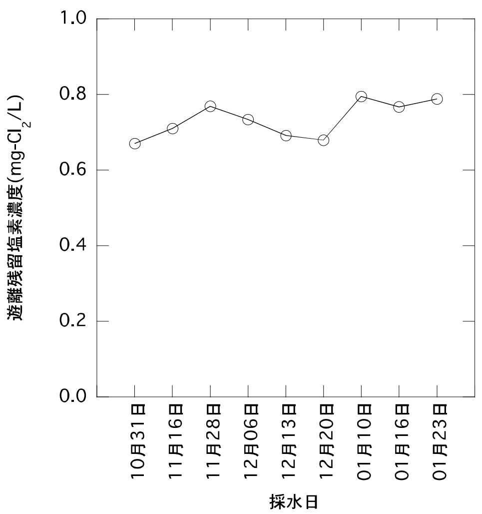


図 27 遊離残留塩素濃度の推移

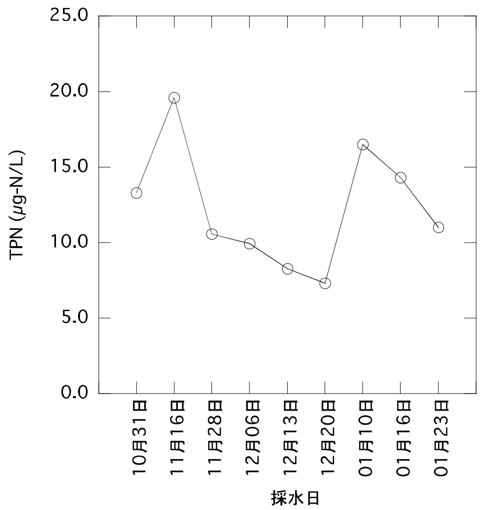


図 28　TPN の推移

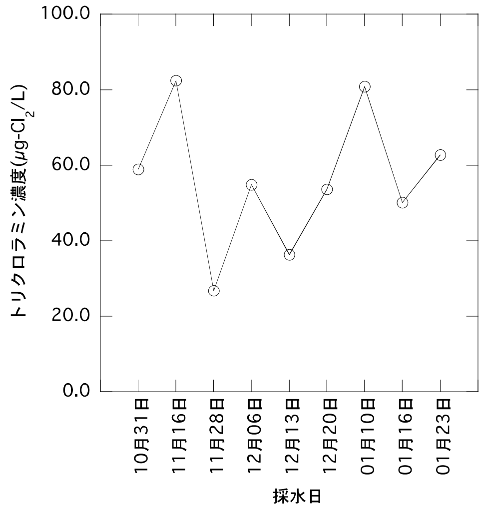


図 29 トリクロラミン濃度の推移

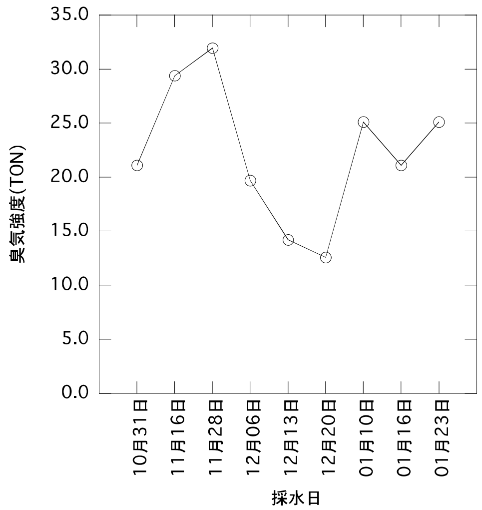


図 30 臭気強度の推移

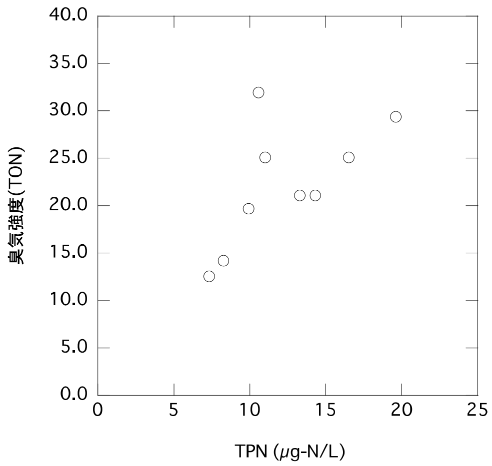


図 31　TPN と臭気強度の比較

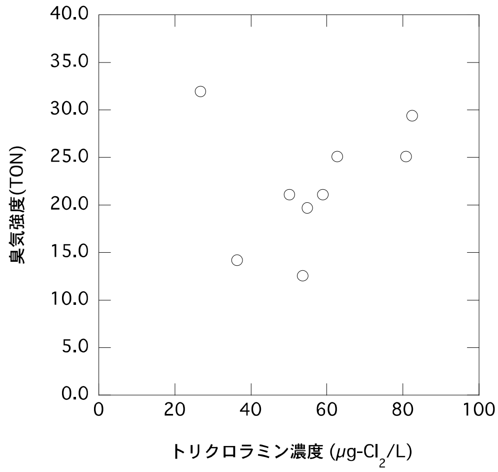


図 32　トリクロラミン濃度と臭気強度の比較

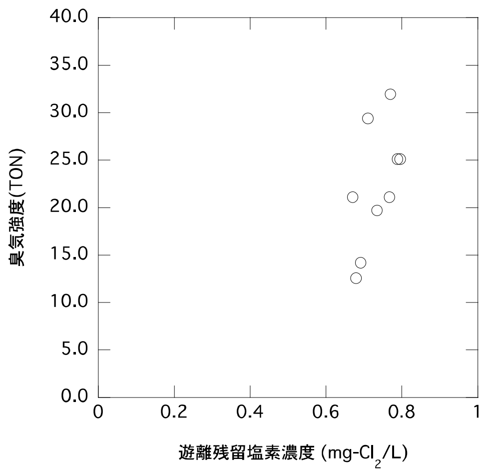


図 33　遊離残留塩素濃度と臭気強度の比較

表 8　塩素注入率を変化させた場合の TPN、トリクロラミン濃度、臭気強度の変化

	採水日	24時間後 遊離残留塩素濃度 (mg-Cl_2/L)	TPN (μg-N/L)	トリクロラミン 濃度 (μg-Cl_2/L)	臭気強度 (TON)	アンモニウム イオン濃度 (μg-N/L)
1回目	10月24日	0.5	10	83	10	31
		1.0	12	117	34	
		1.5	25	204	71	
2回目	1月10日	0.5	8	95	45	48
		1.0	13	116	62	
		1.5	21	152	87	

表９　pH を変化させた場合の TPN，トリクロラミン濃度、臭気強度の変化

	採水日	24時間後 遊離残留塩素濃度 (mg-Cl_2/L)	TPN (μg-N/L)	トリクロラミン 濃度 (μg-Cl_2/L)	臭気強度 (TON)	pH (塩素処理後)
		0.6	12	89	22	
1回目	12月6日	0.6	20	47	41	41
		0.5	5	13	10	
		1.0	17	187	56	
2回目	1月16日	1.1	22	132	67	48
		1.0	9	86	47	