治理技术

白银冶炼厂工业废水治理及其利用

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一、概 述

白银有色金属公司第一冶炼厂，为我国早期建成的大型铜冶炼厂，同时生产硫酸等多种产品．厂内除冶炼外尚包括制酸、电解及综合利用车间．白银冶炼厂所排放的工业废水主要是含酸浓度较低的酸性废水及含酸浓度较高的污酸液．由工业废水中每年要排走 4000—5000 吨硫酸，近千吨重有色金属及砷等物质，严重污染下游水系，并造成了大量资源流失．其中所含污染物 90% 以上来自硫酸车间的制酸烟气洗涤塔所排出的废酸液，虽然废酸液的流量不足全厂排水量的十分之一，但含酸浓度及含重金属离子量却很高，如采用中和法进行处理不仅大量碱性物料供应、制备、投加困难，而且中和渣沉速度慢、渣量大、渣中含水率高、处理效果不稳定，当含酸度超过百分之几时加石灰乳后的沉淀池中只有很少一部分澄清水排出，大量含水率很高的中和渣处理问题很多，也不经济。如渣中再含有某些可溶性的物质，又会产生二次污染．

1978 年白银有色金属公司和北京有色冶金设计研究总院共同组成科研组开始对本专题进行研究，经多方面的工作后重点对硫化法处理污酸液进行较系统的研究，在研究处理效果外也研究如何使废酸净化后可以回用及沉渣中有价物资的回收，并对有关的其他问题等进行了探讨．

二、主 要 试 验

1. 探索性试验

1978 年 10—12 月进行了探索性试验，试样是统一由白银第一冶炼厂硫酸车间三系统第一洗涤塔引出的污酸液，试验时再按需要加水或加硫酸，配成各种酸浓度的试样．

当中和酸浓度为 1% 的试样时，需 7 倍选矿厂尾矿水，9 倍三冶混合精矿溢流水，27 倍三冶选矿厂尾矿水．如果每升加 14g 石灰或者加石灰粉 45g，但中和后的澄清液中砷、氟、镉超出排放标准．当酸浓度增高时，可以看出单纯依靠中和处理法是困难的，处理效果也不稳定．

由于污酸液中含有较多的悬浮物（矿尘等），试验了不同酸浓度情况下的自然沉淀效果与混凝沉淀效果，见表 1．

由表 1 可见，含酸量高时悬浮物沉淀效果变差．加高分子凝聚剂——聚丙烯酰胺(非离子型)，在酸浓度为 5—50% 时加 1mg/L，则有较好的效果．沉淀 5min 超过自然沉淀 4h 的处理效果，但对溶解在污酸液中的金属离子等则需采用其他方法去除．

由于我国有丰富的沸石矿源，沸石耐酸又具有离子交换等特性，因此针对污酸液进行了一系列的试验．在酸浓度为 0.1—4% 的污酸液中加入 10 克沸石粉及 1mg/L聚丙烯酰胺，搅拌及沉淀各 10min 后，上部溶液中砷可除去 20—28.6%，氟除去 13.3—19.4%，

表 1　自然沉淀与混凝沉淀时净化效果*　　(悬浮物单位：mg/L)

沉淀方式	自然沉淀			混凝沉淀
沉淀时间 (min) / 含酸量	10	120	240	5
5%	610→426 (30.2%)	610→16 (97.4%)	610→10 (98.4%)	610→8 (98.7%)
10%	590→521 (11.7%)	590→27 (95.4%)	590→14 (97.6%)	590→12 (98.0%)
20%	550→404 (26.6%)	550→59 (89.3%)	550→32 (94.2%)	550→12 (97.8%)
30%	500→354 (29.2%)	500→68 (86.4%)	500→38 (92.4%)	500→14 (97.2%)
50%	400→370 (7.5%)	400→300 (17.5%)	400→165 (58.8%)	400→19 (95.3%)

* 表中括号内数值为去除率.

表 2　硫化钠对酸液中金属离子等的净化效果*
(单位：mg/L)

原液含酸量	As 砷	Cu 铜	Pb 铅
5%	625→25 (96%)	25→0.4 (98.4%)	125→6 (95.2%)
10%	605→25 (95.9%)	24→1.2 (95%)	120→2 (98.3%)
20%	560→25 (95.5%)	22→0.4 (98.2%)	100→4 (96.2%)
30%	515→25 (95.1%)	20→0.8 (96.0%)	105→4 (96.2%)
50%	410→25 (93.9%)	16→0.8 (95%)	82→4 (95.1%)

* 括号内为去除率.

铜除去 16.7—33.3%，铅除去 70—92.9%(铅在沉淀试验时也能除去部分)。沸石投加量再增加时，去除率也相应增加，但由于沸石容量的限制只能处理金属离子，含量低的水或用于深度净化.

在投加硫化钠的试验中相对效果比较好，现取在 5—50% 的酸浓度中投入 3g/L Na_2S 的结果列于表 2.

由表 2 可以看出，在原液含酸量有较大变化时，硫化法都有较好的处理效果，因此确定以后的试验以硫化法为主进行.

2. 小型动态试验

79 年 3 月至 5 月在现场进行了连续动态硫化法小型试验，处理流量为 0.6—6L/min (一般 3L/min)。Na_2S 加入量为 0.67—6g/L，搅拌方式采用压缩空气。沉淀时间为 20—180min，原液含酸量波动范围为 3—38%，处理效果见表 3.

本次试验由于采用空气搅拌，硫离子(硫化氢)损失较多，对砷的处理效果有时不好。但从总的情况看，只要把硫化剂投加准确，混合、反应、沉淀过程控制好，硫化法对除去污酸中的铜、尘、砷等杂质是有效的.

3. 大型静态试验(半工业性试验)

本次试验于 1979 年 12 月至 1980 年 6 月在冶炼厂硫酸车间三系统进行，由于净化后的酸液又返回生产中使用，因此称为半工业性试验.

表 3 小型硫化法净化试验结果

项目名称	原液 (mg/L)			净化液 (mg/L)			去除率(%)		
	最小	最大	平均	最小	最大	平均	最低	最高	平均
SS 悬浮物	125	800	318	2	100	18.5	77.8	99.2	94.2
As 砷	134	1558	652	14.8	752	237	26.1	96.1	59.4
Cu 铜	8	297	76.3	0.1	9	2.56	88.1	99.8	98.2

表 4 大型静态试验数据汇总表 (单位: mg/L)

项 目	原 液			净 化 液			净化效率%		
	最小	最大	平均	最小	最大	平均	最小	最大	平均
H_2SO_4 硫酸	27400	138200	80340	24500	118040	69610	(1.96)	(16.97)	(13.36)
SS 浊度	76	562	231	1	76	20	60.42	99.74	91.36
As 砷	64	1784	444	0.2	700	74	49.09	99.99	83.35
Cu 铜	8.6	255	59.2	<0.01	0.94	0.2	98.26	99.99	99.66
Hg 汞	0.06	0.6	0.26	≈0	0.023	0.003	87.10	99.99	98.88
Bi 铋	40	800	274	0.5	100	5.21	85.71	99.90	98.10
Se 硒	0.48	9.16	3.74	0.004	0.33	0.081	85.54	99.39	97.84
Pb 铅	5	424	43	3	17.7	7.7	—	96.25	82.10

试验操作次序为将污酸液放入 $\phi 2 \times 2.2$m 搅拌反应槽内，每次 5m³，加入浓度为 10% 的硫化钠溶液，搅拌 30min 后，放入 2.45 × 2.45 × 1.8m (其中斜底高 0.8m) 沉淀槽内沉 2h，上清液取样后用泵扬至生产系统，硫化渣由槽底放出，供压滤试验用. 其它尚有硫化钠溶解槽、溶液槽及硫化氢气体吸收塔等试验设备. 表 4 为试验数据汇总表.

4. 含高砷、铜污酸液静态及动态试验

由于制酸烟气条件变化，当时制酸四、五系统电收尘效率低，出口含尘达 7g/Nm³，洗涤污酸液中砷、铜等含量超过原制酸一、二、三系统数倍至数十倍以上. 对这样高的污酸液采用硫化法于 1981 年 5—8 月在硫酸车间五系统进行了静态及动态试验. 静态处理效果见图 1.

由试验数据可知，在这样高的杂质含量情况下，对汞、硒、尘、铜、铋、砷的去除率都可达 99% 以上，其加药系数 K(实际加药量/该液体总理论需要药剂量)分别为 0.33, 0.43, 0.61, 0.70, 1.03, 1.52. 本试验中也分别测定了在一定范围内渣面沉速，并推算出:

沉速 $u = 10^{-0.143c-0.05}$ (mm/s)

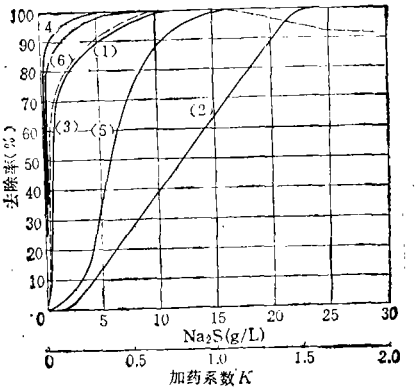

图 1 不同加药量与去除率关系
(1)尘 (2)砷 (3)铜 (4)汞 (5)铋 (6)硒

表 5　动态二段硫化法试验结果*　　(单位: mg/L)

项　目	原　液			一段硫化后出液			二段硫化后净化液		
	最低	最高	平均	最低	最高	平均	最低	最高	平均
SS 浊度	640	1680	1102	80 (83.1)**	284 (87.5)	166 (85)	10 (92.2)	118 (99.1)	47 (95.8)
As 砷	2550	5350	4119	973 (27.2)	3843 (72.6)	2444 (44.3)	625 (54.2)	2500 (82.4)	1186 (71.6)
Cu 铜	1250	4684	2427	119 (53.6)	2010 (93.9)	822 (68.2)	≈0 (99.6)	6.7 (99.99)	3.11 (99.8)
Hg 汞	0.901	1.30	1.014	0.003 (93)	0.063 (99.7)	0.025 (97.3)	0.0005 (99.5)	0.005 (99.95)	0.002 (99.82)
Bi 铋	160	750	344.6	23 (23.3)	468 (85.6)	184.8 (56.1)	8 (80.4)	95.7 (95)	45.7 (87.3)
Se 硒	40.8	69.8	53.67	2.74 (52)	28.1 (94.7)	13.56 (74.8)	0.09 (69.9.4)	12.3 (99)	3.49 (91.6)

* 本阶段试验时因未估计原液中砷铜等含量很高，加药量只加到接近理论值 ($K \approx 0.98$) 因此二段硫化后砷去除率不高.

** 括号内数字为去除率.

式中: c 为 Na_2S 投加量 (g/L)

由沉速规律可以推出，大量的硫化钠加入会使渣面沉速大幅度下降，这样高杂质污酸液处理时为减少沉淀池总面积，或便于硫化渣中各种金属物的分离，宜采用多段硫化.

高砷、铜污酸液动态试验是采用二段硫化法进行. 每段混合反应、沉淀槽形式及尺寸相同，都采用水力变速混合反应槽，设于沉淀池中间. 硫化剂及硫化过程产生的硫化氢气体由进液管吸入. 一段及二段处理效果见表 5. 一段及二段硫化渣分析结果见表 6.

表 6　一段及二段硫化渣成分分析结果(%)

项　目	一段硫化渣	二段硫化渣
Cu 铜	24.75	4.75
As 砷	4.00	22.3
Pb 铅	2.78	0.11
Bi 铋	1.34	3.6
Se 硒	0.48	0.14
Zn 锌	0.38	0.63
Fe 铁	0.24	0.16
Cd 镉	0.18	0.64
Hg 汞	0.03	~0

5. 大型动态试验(工业性试验)

试验设备主要采用改制后的大型静态试验设备，加设了 SO_2 吹脱塔及以铝盐固定氟装置等. 试验日期为 1983 年 10—12 月，试验规模 60m³/d，采用硫酸车间三系统洗涤污酸液进行连续动态处理试验. 净化后的酸液返回烟气洗涤生产系统，占循环酸液量 1/3. 开始试验时，污酸液含酸量只有 38.3g/L，至 10 月 27 日含酸量达到 100g/L 以上后才开始正式试验. 试验中测定了不同加药系数的处理效果. 试验结果基本与静态试验结果相似. 在加药系数 $K = 1.4$—1.6 时的处理效果见表 7.

本次试验中硫化氢废气的吸收装置采用装塑料波片的吸收塔(断面为 1 × 1m²，高度为 4m)，吸收液采用浓度 10% 硫化钠溶液，

表 7 硫化法大型动态试验效果

项 目	H_2SO_4 硫 酸	Cu 铜	As 砷	Bi 铋
处理前酸液 (mg/L)	151,900—154,400	95—110	520—575	650—700
处理后酸液 (mg/L)	145,200—149,200	0.5	11.5—54.5	2.5—4.5
处理后回收率 (%)	94.05—98.22 平均 96.51	99.47—99.55 平均 99.52	89.52—98.00 平均 92.91	99.31—99.64 平均 99.51

吸收 H_2S 气体后溶液回用，排放气体达标.

经处理后的制酸烟气洗涤废酸液经试验可作为选矿厂选硫过程的调整液使用，试验验证对生产指标及废水排放均无影响.

三、讨 论

1. 铜冶炼厂的主要生产原料铜精矿中含硫量很高，冶炼过程排出大量二氧化硫等烟气.为保护环境及回收硫资源，一般冶炼厂同时建立硫酸车间，硫酸列为冶炼厂的第二产品. 冶炼厂工业废水是当地酸及重金属污染的大户，而冶炼厂工业废水最主要的污染源一般是制酸烟气洗涤液. 因即使在电收尘工作正常时，烟气中含尘量也很大需洗涤，二氧化硫中也含有部分三氧化硫（"白银"设计数据 SO_3 占 SO_2 4.2%）. 三氧化硫遇到洗涤水立即变成硫酸. 酸水在反复循环洗涤中，不但硫酸浓度逐步增高，而且同时溶解矿尘中的重金属等，变成杂质含量很高的污酸液，排放量及污染物含量一般比电解、综合回收或硫酸车间等其它排水中要高得多，因此应单独重点处理.

2. 水洗流程制酸烟气洗涤污酸液含酸及杂质量相应比较低，但使用中和法处理很难使净化液稳定达标. 因此很多国家及部门已不允许排污酸水量大的水洗流程制酸系统生产，采用使洗涤酸液反复循环的酸洗流程，排放量虽大大减少，但酸浓度及杂质含量大幅度提高. 这样的污酸液如何处理，我国用各种方式摸索了很多年. 根据试验结果分析，采用硫化法是一种较好的方法，但是否照外国的条件搬套，即用硫化法处理后再中和后排放. 能否将净化后的酸液加以利用，沉渣中的金属加以回收，是值得探讨的. 与白银冶炼厂在一起的白银选矿厂选硫过程中，每年要用数千吨标准硫酸调整 pH 值，经试验可直接采用硫化法净化后的酸液，对生产指标及选厂的废水排放均无影响. 另外净化后的废酸液也可供附近的磷肥厂，作为配酸后生产磷肥用.

3. 硫化渣的量比中和渣少得多，而且在一般情况下不会反溶，不会造成环境污染，但最好是将其中有价值的物质加以回收利用. 一段硫化处理渣中金属品位虽比中和渣高得多，但成分复杂对回收不利. 采用分段硫化法可以较好地将某些元素分开. 如采用二段硫化法可将铜、砷在一、二段硫化渣中分离，一段硫化渣可作为铜精矿，脱水后直接进入冶炼系统炼铜. 二段硫化渣中含砷品位较高，应进一步研究利用方式. 另外，在硫化处理前如增加聚丙烯酰胺的混凝沉淀设施，又可将铜等物质回收，白银污酸液中铋含量很高，硫化法处理效果好，也应考虑回收.

4. 硫化法条件控制精确时，汞、硒、铜、铋、砷、尘的去除率都可达 99% 以上. 但设计选用及制定生产控制指标时应考虑多方面因素，其中砷的硫化过程是在汞、硒、铜、铋之后，要投加较多的硫化剂时才能沉淀分离彻底，但加硫化剂多时沉速大幅度减慢. 因此，砷的去除率不宜选用太高指标，根据实际需

要选定。在高含酸量的情况下，硫化法对处理铁、锌、镉、氟等效果不好，中和处理应首先考虑利用废碱液，如送入尾矿池统一处理等方式。

5. 本法采用使进污泥间与硫化剂混合并压送至反应槽底的水力变速反应装置，处理效果较好，在此设备上还加装了硫化氢气体回流设施，能将液面逸出的 H_2S 全部回收，比国外处理系统减少了 H_2S 吸收塔、除害塔、风机、排放筒及氢氧化钠溶解、添加装置等。

6. 硫化剂一般可采用硫化钠，硫氢化钠或硫化氢气体，就减少带入的钠量来说，硫化氢最好，不带入钠。硫氢化钠带入钠量比硫化钠少一倍。

7. 白银冶炼厂最近已在硫酸车间建成一座冶炼烟气洗涤污酸液硫化法处理站，试车后硫化法处理系统运行正常，但酸液回用及金属回收等有待前后其他系统的完善，如对处理后的废污酸加以利用，硫化剂采用兰州炼油厂工业废液，并逐步将沉渣中铜、硒、铋、砷等加以冶炼回收，直接经济效益每年将超过百万元，因此硫化法的试验成功不但有环境效益、社会效益同时也有经济效益。

参 考 文 献 略

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水煤浆在复合前置燃烧室内低 NO_x 排放的研究

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近年来，随着水煤浆燃烧技术的不断发展，采用复合前置燃烧室作为一种新型的煤浆燃烧设备已得到初步的研究[1,2]，并将走向工业性试验。本文在以往浙江大学燃烧教研室研究煤及水煤浆沸腾燃烧过程中 NO_x 的生成理论基础上[3,4]，对水煤浆、油等燃料在复合前置燃烧室内，雾炬燃烧过程中 NO_x 的生成进行了研究。通过大量的试验，证实了采用分段送风燃烧等方法的复合前置燃烧室是一种理想的低 NO_x 排放燃烧设备。

一、试验装置及方法

试验是在浙江大学燃烧实验室的复合前置燃烧试验装置上进行的，如图 1 所示。该试验装置由立式预燃室，燃烧室、混合室、喷动床以及模拟炉膛组成。预燃室直径为 300mm，燃料和一次风由顶部加入，一次风可直流或旋流。二次风在燃料燃烧着火一定距离后加入，为旋转风。底部喷动床鼓入少量喷动风，能托起分离下来的部分未燃尽的结团煤浆粒子，减少机械不完全燃烧损失。三次风的加入，能补充煤浆燃烧后期所需的氧量，使燃尽率提高。高温烟气经模拟炉膛及除尘器后，由烟囱排入大气中。

燃烧过程中，烟气氧量由 CY7 测氧仪及气敏色谱仪分析测定，NO 及 NO_x 用 RS-325L NO_x 分析仪测定，事先这些仪表都进行过标定。炉内火炬及高温烟气温度由水冷铂铑-铂热电偶进行测定。整个测量系统如图 2 所示。

that PSB is suitable to high load treatment. In this investigation, the principle and method for treating effluence of PSB stage has been considered. (See pp. 16—19).

Major Bacterial Populations and Their Function in Printing-Dyeing Wastewater Treatment System

Zhang E and Sheng Lingling (Yunnan Institute of Microbiology, Kunming)

This paper deals with an investigation of the bacteria populations which were isolated from activated sludge from wastewater of the Yunnan Printing-Dyeing Mill and had the function of purifying wastewater. 75 strains of bacteria, 5 strains of actinomyces and 2 strains of fungi were isolated, and identified to genus, 14 genera in total, among which some strains of *Pseudomonas, Zoogloca* and *Flavobacterium* were predominent. C_{28} (*Proteus* sp.) has strongly decolorizing effect on the wastewater containing azo dyes, when it is used simultaneously with activated sludge, decolorizing rate can reach above 90%.
(See pp. 20—24)

Effects of Simulated Acid Rain on Growth of Tomato (*Lycopersicon esculentum*)

Chen Yugu et al. (Chengdu Institute of Biology, Academia Sinica, Chengdu, Sichuan Province)

Results of the experiment showed that growth of tomato (*Lycopersicum esculentum*) could be affected by simulated acid rain in two soils (fluviogonic soil and acid yellow soil). The pH values of the simulated acid rain were 4.5, 3.5, 2.5 and 5.6 (ck) respectively. There appeared visible injurious symptoms (chlorosis and necroses) on the leaves of tomato after the simulated rain of pH 2.5 was sprayed. However, at pH 4.5, the symptoms were slight. Owing to increases of acidity of 4.5, 3.5 and 2.5, the fresh of tomato fruit weighed decreasingly by 13.8% 34% and 38.2% in fluviogonic soil respectively and 3.5% (pH 4.5) and 28.8% (pH 2.5) in acid yellow soil.
(See pp. 24—28)

Accumulation and Depletion of the Pesticide *Fenitrothion* in Fish Sampled from Paddy Field

Lou Genlin, Zhang Zhongjun et al. (Institute of Plant Protection, Sichuan Academy of Agiculture, Chengdu)

The behavior of *fenitrothion* in the aquatic ecosystem of paddy field was presented in this paper. Field experiment was performed during 1986—1987 near Chengdu City. The results showed that the pesticide was absorbed moderately by fish in 24 hours and decreased rapidly after one day. Half-life (HF_{50}) of it was about two days. Residue of *fenitrothion* in fish viscera was more than in fish meat. The pesticide residue in fish will thus be depleted as the polluted fish is short-termly cultured in clean water. (See pp. 28—33)

A Research on the Discharge Standard of Maximum Permissible Concentration of Cadmium in Shanghai Sewerage System

Chen Boqi (Shanghai Municipal Centre of Environmental Monitoring, Shanghai)

By simulated tests of activated sludge process with toxicant cadmium (Cd) in the laboratory, the results showed that to a certain concentration of Cd, biological treatment of wastewater was gradually depressed as its concentrations increased. Cd residue in effluent increased as its concentretion in influent got high, and decreased as sustained time of sludge increased. Cd concentration in mixed liquid hadnot a tangible impact on sludge in second sedimentation tank. Based on the results, the author offered a proposal for reviewing the discharge standard of maximum permissible concentration of Cd in Shanghai sewerage system (See pp. 33—37)

Studies on Treatment of *Beiyin* Smelter Process Effluent and Its Utilization

Ni Dong (Beijing Design-Research Institute of Nonferrous Metallurgy, Beijing)

Beiyin Smelter is a large-scale copper smelter built in early 1950s. The metallurgical gas from the Smelter is utilized to produce sulphuric acid and other products. The waste process effluents contain a lot of acid, arsenic, copper bismuth, lead, selenium and mercury etc, which are mainly concentrated in the effluents obtained from scrubbing of acidmaking gas. The acidic effluent with a high content of arsenic and copper is not only very harmful to the lower reaches of the river, but also causes big loss of valuable material.

It is showed through studies that the sulphide agent (sodium sulfhydrate and sodium sulphide solution of S^{2+}-containing waste solution), in the presence of acid, can be directly added to precipitate mercury, copper and arsenic in the form of sulfides for recovery, also the impurities, such as lead and dust etc in the acidic effluents are settled down efficiently, so that the acidic effluents after treated, can be utilized too, for instance, for making phosphate fertilizer.

It is indicated that by use of the multi-stage sulfidization process, copper and arsenic etc could be seperated from the precipitate for recovery or storage. By adoption of a new equipment for sulfidizing and mixing reaction

and for direct recovery of hydrogen sulfide, the treatment results are improved, the process is simplified and less equipment is required. (See pp. 40—45)

Research on Emission of NO_x in the Pre-Combustor of Coal Water Slurry (CWS) Spray Combustion

Cao Xinyu et al. (Zhejiang University, Hanzhou)

A study of formation and emission of NO_x in the pre-combustor of coal water slurry (CWS) and oil spray combustion has been presented in this paper. The experiments showed that emission of NO_x and flame temperature in two-stage burning were lower than that in one-stage burning. The emission of NO_x was lower than 150 ppm (based upon 6% excess of air), as using pre-combustor in burning coal water slurry. Thus CWS may be considered as a cleaning fluid fuel, and the pre-combustor is a less pollution combustion device, (See pp. 45—49)

Determination of Calcium and Magnesium in Water Samples Using Semi-Automatic Photometric Titration

Zhu Jianzhong et al. (Shanghai Institute of Metallurgy, Academia Sinica, Shanghai); Chen Zhengfu et al. (Shanghai Environmental Monitoring Centre, Shanghai)

Calcium and magnesium in water samples were determined by using an apparatus with a dual-wavelength fiber-optic probe for semi-automatic photometric titration. The subtraction of the signals of two light beams of different wavelength which pass the same titration solution eliminated the turbidity and dilution effects and increased titration sensitivity. No interference was found as the amounts of suspension was less than 20 mg in 50 ml sample solution. It took 1—2 min. for single titration. The limits of detection and measurement range of calcium and magnesium are 0.14 μg, 0.09μg (3.6×10^{-9} mol) and 4μg—40mg 2.4 μg—24mg respectively. R. S. D. and recovery of this method are 0.12% and 101.2% respectively. Analytical results of this method for six kinds of water samples are in agreement with that of A. A. S. method (See pp. 50—53)

Iodometric Once Determination of BOD_5

Han Xiangkui, Jin Chengji and Xu Lijuan (Harbin Institute of Architecture and Civil Engineering, Harbin)

A sensitive, accurate and handy method is presented for determination of BOD_5. Two flasks of culture solution were prepared. Solution of mercuric chloride or concentrated hydrochloric acid was put into one flask, so that the bacteria in it would lose activity. Then two flasks were cultured at same time. Five days after, the dissolved oxygen was determined using iodometry, by which value of BOD_5 was once measured. This method would avoid interference of consumed oxygen of chemical oxidation. (See pp. 53—56)

Principles and Procedures of the Design of Regional Environmental Management Information Systems

Cheng Shengtong et al. (Dept. of Environmental Engineering, Tsinghua University, Beijing)

Environmental Information Data Base (EIDB) is one of the key projects in China during 7th Five-Year Plan. The authors offered a proposal on the principles and the methods of the system design as follows: the environmental Information and its features, the basic model of environmental management and its information system in China, the function analysis on regional environmental management in operation, principles of design and the developing procedure of regional environmental management information system.

Based on the tenets of management information system and the real situation of China, the principles and the procedures of regional environmental management information system (REMIS) have been proposed in this paper. (See pp. 57—61)

Application of Group Analytical Hierarchy Process to the Problems of Beijing Water Resources

Huang Ganliang et al. (Beijing Municipal Research Institute of Environmental Protection, Beijing); *Xu Shubo* (Institute of Systems Engineering, Tainjin University)

For the purpose of studying serious water shortage in Beijing area and its countermeasures available, group AHP was used to synthesize the opinions and judgements of 63 experts from all walks of life in Beijing in this paper. Five rounds of expert consultation were done, and the model structure was established on the basis of first round expert consultation and repeated discussion and consideration. Eigenvalue method was chosen for the calculation of the system on computer Victor-9000. In order to reduce the errors of results, fuzzy treatment was adopted and structure treatment was conducted. In result, the composite weight of strategic objective level, of constraint level, of measurement level as well as alternative level were completed and its corresponding priorities were set up. (See pp. 61—67)