

活化粉煤灰在橡胶制品中应用的研究*

吕瑶皎 张季爽 侯让坤** 彭小平 韩文

(湖南大学环境工程系, 化学化工系, 长沙 410082)

摘要 本研究是将多种活化粉煤灰应用于橡胶制品中分别代替活性碳酸钙, 轻质碳酸钙和中超炭黑作填料或补强剂。结果表明, 良好的活化剂是获得优良活化灰的关键因素之一, 粉煤灰的粒度和其表面性能是影响复合材料机械性能的主要因素。用良好的活化剂, 采用干法研磨的活化方法可以兼顾这 2 个因素, 获得较理想的活化灰, 活化灰与有机物能很好地相容, 加上它的球粒结构, 因而有很好的加工性能。在橡胶制品中用活化灰全部代替活性碳酸钙, 各项物理机械性能均符合要求, 半代轻质碳酸钙也是可行的, 而用它代替中超炭黑作补强剂时, 其代用量应在 1/2 以下。由于粉煤灰呈现灰色, 因此不适用于浅色和鲜艳色的制品中。

关键词 粉煤灰, 橡胶, 表面改性。

在我国粉煤灰是一种数量巨大, 增长速度极快的固体废物。目前年排放量近 $8 \times 10^7 \text{t}$, 利用率为 31.9%。预计到 2000 年粉煤灰排放量将达 $1.2 \times 10^8 \text{t}$ 以上^[1]。为提高粉煤灰的综合利用率, 必须从多方面开展综合利用的研究。将粉煤灰应用于橡胶制品中, 减少橡胶和炭黑等填料的用量, 可收到明显的环境效益和经济效益。

粉煤灰是由不同结构和形态的微粒组成的高分散体系, 它具有稳定的物理化学特性。但是它与有机物的相容性差, 制约了它在有机材料中的用量和性能。为了使其在加工工艺、产品性能等方面更加符合有机材料的要求, 须将粉煤灰进行表面改性处理^[2,3], 将得到的活化粉煤灰再应用于橡胶制品之中。

1 实验

1.1 实验原料

本实验采用了湘潭电厂的浮选粉煤灰、岳阳华能电厂的粉煤灰和株洲电厂粉煤灰及微珠, 其主要组成如表 1(本科研组分析)。粒径分布如表 2(湖南大学环境保护研究所分析)。

表面改性剂有 HNA 型、HR 型、GR 型、4191 型、HN 型和 163BN 型(以上为本科研组研制); 南大-42、南大-73(江苏省江宁县秣陵化工厂); G-402 和 G-439(辽宁省盖县化工厂)。其它常用试剂和有机溶剂。

1.2 主要仪器和设备

球磨机, 恒温箱, NDJ-2G 旋转粘度计, 粒径分析仪及其它常用仪器与设备。

1.3 粉煤灰的活化

经反复实验得出, 粉煤灰活化以干法为好, 较理想的活化方案是: 选择活化剂的良好溶剂将活化剂溶解并稀释后, 与一定比例的粉煤灰混合均匀, 加到球磨机中边研磨边活化反应 4h, 取出样品在选定温度下烘干即可。(活化剂用量因活化剂和要活化的粉煤灰粒径不同而不同, 一般是粉煤灰重量的 0.6%—1.2%^[2,3], 溶剂用量为粉煤灰重量的 4% 左右。)

1.4 粉煤灰填充橡胶制品和性能测试

粉煤灰作橡胶制品试样及性能测试由湖南省橡胶制品质量监督检验站和湖南省醴陵市橡胶厂进行。

2 结果与讨论

2.1 活化粉煤灰代替活性碳酸钙作橡胶的填料试样基本配方如表 3。

用多种粉煤灰全部代替配方中活性碳酸钙在湖南省橡胶制品质量监督检验站做样并测试性能, 结果列于表 4。

• 国家自然科学基金资助课题

* * 河南教育学院

收稿日期 1994-02-17

表 1 几种粉煤灰的主要成分(W%)

煤灰种类	成 分					
	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	烧失量
株洲电厂粉煤灰	45—49	22—31	3—5	1.4—2.6	1.2	7—16
湘潭电厂浮选粉煤灰	42—57	23—30	3—8	2—7	0.5—2	5—10
华能电厂粉煤灰	48—60	23—31	5—8	3—7	0.2—2	2—3

表 2 几种粉煤灰的粒径分布

煤灰种类	中位径(μm)	频率最大的粒径(μm)	75%灰的粒径(μm)	25%灰的粒径(μm)	比表面积(m ² /g)
株电灰	34.30	24.97	≤65.71	≤19.38	0.192
湘电浮选灰	37.10	25.53	≤64.81	≤19.98	0.197
株电微珠	12.58	12.90	≤15.37	≤9.92	0.432

表 3 活性碳酸钙橡胶试样基本配方¹⁾

成分	烟片胶	硫磺	促进剂 M	氯化锌	硬脂酸	活钙	总计
重量份数	100	3	1	5	2	78	189

1) 硫化条件:128℃,35min,45min。

表 4 橡胶试样性能测试结果¹⁾

试 样	实验条件			实验项目			
	温度(℃)	相对湿度(%)	时间(min)	硬度(邵尔)	300%定伸应力(MPa)	扯断伸长率(%)	拉伸强度(MPa)
活性碳酸钙橡胶	26	69	35	57	3.90	636	20.91
			45	57	3.35	661	19.60
未活化粉煤灰橡胶	25	55	35	60	2.47	530	6.76
			45	60	2.43	520	6.25
1%硬脂酸钠处理的湘浮灰	25	68	35	58	2.40	607	10.48
			45	58	2.31	598	9.65
1%NH 活化筛分—300 目的湘浮灰	28.5	63	35	64	3.68	536	13.39
			45	64	3.42	542	13.00
1.2%NH 研磨活化 4h 的湘浮灰	24	70	35	67	4.22	520	14.51
			45	67	4.58	530	15.88
0.8%HR 活化的株电微珠	25	68	35	58	3.23	623	14.53
			45	58	2.98	630	13.80
0.8%HR 活化的株电—300 目灰	23.5	70	35	57	3.42	640	17.74
			45	57	3.11	630	16.18
0.8%HNA 活化的株电—300 目灰	23.5	70	35	57	2.72	640	15.38
			45	57	2.55	640	14.57

1) 橡胶行业部颁标准为:一级:扯断伸长率≥500(%),拉伸强度≥14MPa,二级:扯断伸长率≥480(%),拉伸强度≥13MPa。

由表 4 看出,不经任何处理的粉煤灰直接用来作橡胶填料,其拉伸强度与制品质量要求相差很远。在原粉煤灰粒度的基础上对其进行表面改性,其力学性能有很大提高,但仍不能满足质量要求,如果对粉煤灰进行筛分,收集—300 目以下的组分,或是直接用分选出的微珠进行表面改性处理,或用活化剂与原粉煤灰一起研磨活化 4h,用这些活化灰作填料,所得样品的性能都能

达到质量指标的要求。这说明粉煤灰的表面性质和其粒径分布是影响橡胶制品质量的 2 个主要因素。经活化处理的粉煤灰在这 2 方面均能满足其要求。同时还可以看出,使用不同类型的活化剂,对橡胶各种性能影响的程度不一样。如用 HN 型活化剂处理的灰其硬度和 300%定伸应力提高较其它的多,而扯断伸长率又不如其它活化

剂。因此可据具体要求选用不同的活化剂。

2.2 活化粉煤灰代替轻质碳酸钙作橡胶填料试样基本配方如表 5。

用多种粉煤灰全部或部分代替基本配方中的 CaCO_3 ,在湖南省橡胶制品质量监督检验站制样并测试性能,结果列于表 6。

由表 5 看出,在基本配方中碳酸钙用量很

表 5 轻质碳酸钙橡胶试样基本配方

成分	3#烟片胶	硫磺	促进剂 M	促进剂 D	ZnO	硬脂酸	CaCO_3	锭子油	共计
重量份数	100	2.20	0.85	0.20	5.00	2.00	138.25	1.50	250

表 6 橡胶试样性能测试结果¹⁾

试样 编号	实验条件			实验项目						
	温度 (℃)	相对湿度 (%)	时间 (min)	硬度 (邵尔)	300%定伸应力 (MPa)	扯断伸长率 (%)	拉伸强度 (MPa)	扯断永久变形 (%)	密度 (g/cm ³)	磨耗减量 (cm ³ /1.61km)
①	21.5	85	10	69	4.96	530	11.66	30	1.47	1.41
			15	69	5.21	530	11.35	31		
			20	68	4.74	500	10.64	27		
			25	69	4.60	510	11.26	30		
②	21.5	85	10	65	3.55	560	12.64	29	1.45	2.58
			15	66	3.45	550	11.28	29		
			20	66	3.45	560	10.53	27		
			25	66	3.29	570	10.69	27		
③	21.5	85	10	68	4.08	510	10.96	30	1.49	1.59
			15	70	4.49	500	10.78	31		
			20	71	4.11	490	9.41	30		
			25	71	4.29	490	9.15	30		
④	21.5	85	10	68	3.85	570	11.41	27	1.45	1.72
			15	68	3.87	550	9.44	22		
			20	68	3.69	530	8.99	23		
			25	68	3.52	530	8.64	23		
⑤	26	82	10	70	5.03	494	12.87	30	1.47	1.45
			15	71	4.84	478	11.48	31		
			20	71	4.91	478	11.50	31		
			25	71	4.88	475	11.28	31		

1)各试样中填料分别为:①轻质碳酸钙 ②1.5%的 4191 研磨活化 4h 的湘电浮选灰 ③1.2%HR 研磨活化 7h 的湘电浮选灰
④0.8%HR 研磨活化 4h 的华能电厂灰 ⑤一半轻质碳酸钙,一半 1.2%HN 研磨活化 4h 的华能电厂灰

大,占总量的 55.3%。因此全部用活化粉煤灰代替碳酸钙的橡胶制品的拉伸强度和磨耗 2 项指标不如碳酸钙制品,其余均能达到要求。由表 6 知,由于活化剂不同(②与③)各灰样所得制品性能也不同;活化剂相同,而粉煤灰品种和活化时间不同(③与④),其橡胶试样的性能也有差异。

如果只用活化灰代其中一半碳酸钙,其橡胶试样的各项性能均能与碳酸钙作填料的试样相比。因此,在深色橡胶制品中加入部分活化灰代替碳酸钙是完全可行的,它不但可降低成本,而且可提高制品的耐腐蚀性能。

2.3 活化粉煤灰代中超炭黑作橡胶补强剂

选取几种活化粉煤灰送湖南省橡胶制品质量监督检验站全部或部分代替配方中中超炭黑制取橡胶试样并测试性能。其基本配方如表 7，测试结果如表 8。选 2 种活化灰送湖南省醴陵市橡胶厂按该厂三角带底胶和运输带复盖胶的生产配方，全部代替其中炭黑制样并测试性能，结果列于表 9 和表 10。

由表 8 结果看出，在通用炭黑配方中，用活化灰全代炭黑的橡胶制品其性能难以达到指标

要求。这主要是因为炭黑的粒径远比粉煤灰细得多，而细度又是影响橡胶制品性能的关键因素之一。其次是配方没有因原料不同而作相应的调整。因此不能达到理想的取代效果。减少粉煤灰用量，只用活化灰代替一半炭黑，其测试结果表明，300%定伸应力增加到原来的 3 倍，如果继续减少用量(如减至 1/3)，并对其配方进行适当调整，则可望满足要求。这样可节约价格贵的炭黑，取得较好的经济效益。

表 7 通用炭黑基本配方¹⁾

成分	天然胶	硬脂酸	ZnO	促进剂 DM	硫磺	炭黑	共计
重量份数	100	3	5	0.6	2.5	50	161.1

表 8 橡胶试样性能测试结果

试样 编号	实验条件			实验项目				
	温度 (℃)	相对湿度 (%)	时间 (min)	硬度 (邵尔)	300%定伸应力 (MPa)	拉伸强度 (MPa)	扯断伸长率 (%)	扯断永久变形 (%)
①	21.5	85	15	73	14.31	28.18	550	33
			30	73	15.69	26.11	490	30
②	21.5	85	15	53	2.47	21.93	750	30
			30	53	2.45	18.65	740	23
③	21.5	85	15	58	3.63	22.09	650	31
			30	58	3.47	19.58	650	27
④	24	70	15	68	9.53	22.42	500	34
			30	68	10.12	19.64	480	28
⑤	24	70	15	64	7.97	22.96	550	30
			30	64	8.02	20.27	500	20

1)表中各试样所用补强剂分别为:①中超炭黑 ②0.8%HN 研磨活化 10h 的湘潭电厂浮选粉煤灰 ③1%HN 水磨活化湘电浮选灰 ④1.2%HN 活化磨细后筛分得的-400 目湘电浮选灰一半,炭黑一半 ⑤1.2%HN 活化原灰筛分-400 目湘电浮选灰一半,炭黑一半。

表 9 三角带底胶试样物理机械性能试验结果¹⁾

试样	硫化条件 (℃×min)	扯断力 (MPa)	永久变形 (%)	伸长率 (%)	300%定伸应力 (MPa)	硬度 (邵尔)
①	150×8	130	25	460	71	67
	150×12	114	25	480	59	67
②	150×8	69	22	490	36	59
	150×12	64	20	490	41	60
③	150×8	80	25	540	34	63
	150×12	75	25	490	45	64
国家标准		≥120	≤35	≥300		

1)各编号试样为:①醴陵市橡胶厂用炭黑补强的胶样 ②用 1.2%HR 研磨活化 7h 的湘电浮选灰全代炭黑 ③1.2%HN 研磨活化 7h 的湘电浮选灰全代炭黑

表 10 运输带复盖胶试样物理机械性能对比试验结果¹⁾

试样	硫化条件 (C × min)	扯断力 (MPa)	伸长率 (%)	永久变形 (%)	300%定伸应力 (MPa)	硬度 (邵尔)
①	150×8	175	590	30	66	61
	150×12	163	600	30	60	61
②	150×8	118	730	20	17	45
	150×12	141	680	20	26	49
③	150×8	130	680	20	29	50
	150×12	142	650	20	35	54
国家标准		≥400	≥177			

1)各编号试样同表 9

由表 9 和表 10 看出,按生产厂家原始配方用粉煤灰全部代替炭黑,其物理机械性能中的扯断力与国家标准相比相差很远,但与厂家对比试样比较差别还不是很大,其余指标均符合国家标准,其中③号样性能又优于②号样。如果在此基础上选择更理想的改性剂,获得性能更好的活化灰,适当调整配方和减少粉煤灰的代用量,则完全有可能运用于生产之中,达到降低成本保护环境的目的。

3 结论

(1)用偶联剂和表面活性剂对粉煤灰进行表面改性处理,改性剂用量不大,却能显著改善粉煤灰的表面性能^[2,3]。良好的活化剂是获得优良活化灰的关键因素之一。粉煤灰的细度和其表面性能是影响复合材料机械性能的主要因素。用良好的活化剂,采用研磨活化的方法可以兼顾这 2 个因素,获得较理想的活化灰。

(2)活化粉煤灰应用于橡胶制品中,由于表面的亲油性^[2],使它能与其他组分充分均匀混合,加上它的球粒结构,使得有很好的加工性能。又由于它具有耐热和耐腐蚀等特性,如运用恰当,不仅可降低复合材料成本,而且能改善复合

材料的某些性能。

(3)试验结果表明,在橡胶制品中用活化粉煤灰全部代替活性碳酸钙,各项物理机械性能均合要求。半代轻质碳酸钙也是可行的。而用它代替中超炭黑作补强剂,则代用量应在 1/2 以下。为了提高其代用量并取得好的结果,还应对其配方进行研究改进。

(4)由于粉煤灰呈灰色(最好用 C<5% 的粉煤灰),因此不适用于浅色和鲜艳色的制品中。

(5)粉煤灰是一宗庞大的再生资源,进一步研究灰的活化及其应用,必将进一步扩大粉煤灰的应用范围,这是一条治理环境,开发资源的好途径。

致谢 环境工程系 92 届毕业生刘军生、付先元、王训规和贺文胜参加了部分实验工作,湖南大学环境保护研究所裴清清帮助做了粉煤灰的粒径分析,在此致以衷心的感谢。

参考文献

1 赵鹏高. 电力环境保护. 1993, 9(4): 40
2 吕瑶姣, 张季爽. 环境科学. 1992, 13(4): 45
3 吕瑶姣, 张季爽. 湖南大学学报(自然科学版), 1992, 19(1): 104

Chinese Academy of Sciences, Beijing 100085); *Chin. J. Environ. Sci.*, **15**(5), 1994, pp. 19—22

A typical region with various types of topography extended from the Taihang Mountains to the ancient course of the Yellow River was selected to study the relationship between the contents of the available species of six trace elements in soil, which were essential for plants to grow, and the topographical changes. The results show that the level of water soluble boron species in soil was increasing with the topography dropping; the level of easily reducible manganese species changed in consistence with the topography; the level of molybdenum species was the lowest in mountainous areas and lowlands; the level of zinc was generally lower in most areas; and the level of copper was middle or higher in all the soils of various topographies. The results obtained provide a scientific basis for the application of trace elements fertilizers to soil and the studies to find the causes for abundance or deficiency of various elements in different topographies.

Key words: topography, trace elements, soil.

Study on the Methane Emission from Spring Rice Fields in Beijing. Zhang Jianbo et al. (Center for Environ. Sciences, Dept. of Technical Physics, Peking University, Beijing 100871); *Chin. J. Environ. Sci.*, **15**(5), 1994, pp. 23—26

The emission of methane (CH_4) from spring rice fields under different field managements was measured in Beijing in 1991. Under the traditional practice of local agricultural management, the CH_4 emission flux was found to have a mean value of $8.7\text{mg}/(\text{m}^2 \cdot \text{h})$. The seasonal variation in CH_4 emission was observed with the peak values occurred in the tillering and flowering phases. The redox potential in soil was found to be correlated with CH_4 emission. The organic manures applied in field resulted in an increased CH_4 emission. Intermittent irrigation on a scientific basis to have an alternating dry and flooded paddy may be an effective way to increase rice yield and to reduce CH_4 emission. Direct dry-sowing technology may largely out down CH_4 emission but may reduce rice yield that needs to be further studied.

Key words: methane emission, rice field, emission flux, field management.

Study on the Photolysis of Dimethyl Sulfide and the Rate Constant of Forming Dimethyl Disulfide. Zhong Jinxian, Yang Wenxiang et al. (Research Center for Eco- Environmental Sciences, Chinese Academy of Sciences, Beijing 100085); *Chin. J. Environ. Sci.*, **15**(5), 1994, pp. 27—30

Dimethyl sulfide (DMS) was irradiated with a low pressure mercury lamp and then the photolytic products were detected with a Fourier transform infrared spectroscope in a long path cell of 20m at different times. The results show that dimethyl sulfide was photolyzed to form dimethyl disulfide and ethane by following a first order reaction, with a

rate constant of $8.70 \times 10^{-5}\text{s}^{-1}$ for the formation of dimethyl disulfide. A system of $\text{DMS} + \text{H}_2\text{O}_2$ and a system of $\text{DMS} + \text{NO}$ were also studied by using the same method. It was found that in the presence of sufficient H_2O_2 , DMS was photolyzed to form CH_2O and $\text{CH}_3\text{SO}_3\text{H}$. In the case of $\text{DMS} + \text{NO}$, the photolytic products were CH_3SSCH_3 , C_2H_6 and CH_3SNO .

Key words: dimethyl sulfide, photolysis, rate constant of reaction.

Pilot Study on the Industrialized Production of chrome Pig Iron Smelted from a Sintered Chrome Slag Ore. Liu Dayin and Zhou Caixin et al. (Dept. of Environ. Eng., Huangshi College 435000); *Chin. J. Environ. Sci.*, **15**(5), 1994, pp. 31—34

A pilot study on the industrialized production of chrome pig iron was carried out in a small-sized blast furnace of 30m^3 by using a sintered ore of chrome slag as flux. $\text{Cr}(\text{VI})$ in chrome slag was reduced at a rate of near 100% and more than 94% of total chromium were reduced metallizationally. The consumption of slag per tonne of product iron was 2.298t on average with the maximum of 2.785t. For smelting a chrome pig iron containing more than 10% Cr, it was necessary to simultaneously add chromite in order to increase the level of chromium. By keeping the furnace temperature at over 1480K, controlling the alkalinity at a lower level and adding the subsidiary burden to reduce the melting point of furnace slag, the mobility of furnace slag was significantly improved that resulted in the successful separation of iron from slag. The secondary pollution during the pilot study was monitored and it was found that it was necessary to control the dispersion of blast furnace gas in order to reduce the deposition of dust from the production process.

Key words: chrome slag, use of waste as a resource, blast furnace, iron smelting, chrome pig iron.

Study on the Application of Activated Coal Ashes in Rubber Products. Lu Yaojiao, Zhang Jishuang et al. (Dept. of Environ. Eng., Hunan University, Changsha 410082); *Chin. J. Environ. Sci.*, **15**(5), 1994, pp. 35—39

A study was carried out on the application of many kinds of activated pulverized coal ashes to replace activated calcium carbonate, light calcium carbonate or medium- super carbon black as fillers or reinforcers in rubber products. The results show that better activating agents are one of key factors to obtain the activated pulverized coal ashes of high quality, and the particle sizes and surface properties of the coal ashes are the major factors affecting the mechanical performances of composite materials. The use of both better activators and dry grinding activation processes can incorporate the above factors to obtain more preferable activated coal ashes, allowing them to be well compatible with organic components, which are coupled with its

spheric particle structure to make it excellent in workability. The rubber products in which all calcium carbonate have been replaced with the activated coal ashes have all physical and mechanical properties meeting the requirements, those in which a half of light calcium carbonate have been replaced with the same are also practicable, and those in which less than 1/2 of medium-super carbon black have been replaced with the same can be useful. Due to its grey colour, the activated coal ashes are not suitable to be used in the products with a light or bright colour.

Key words: coal ash, rubber, surface modification.

Study on the Simultaneous Removal of SO₂/NO_x from Flue Gases with Absorption and Catalysis.

Sheng Deshu, Zhao Xin et al. (Dept. of Environ. Eng., Hunan University, Changsha 410082); *Chin. J. Environ. Sci.*, **15**(5), 1994, pp. 40—42

Based on the requirements for simultaneous desulfurization and denitrification, a study was carried out on the preparation and reaction processes of the catalysts consisting of CuO as a major active component. The results from activity measurements indicate that the catalyst has the optimum activation temperature of 450 °C and the activation time of 2h. Under the conditions of reaction temperature of 400 °C, space velocity of $2 \times 10^4 \text{ h}^{-1}$, CuSO₄/CuO ratio by mole of over 1.46 and Cu/S ratio by mole of over 0.83, both SO₂ and NO_x can be removed at a rate of over 90%.

Key words: simultaneous desulfurization and denitrification, catalyst, treatment of waste gases.

Study on the Treatment of Wastewater from the Production Process of Jiemycin.

Lin Shiguang (Center for Environ. Control, Zhongshan (Sun Yetsen) University of Medical Science, Guangzhou 5100631), Luo Guowei et al. (Institute of Environ. Sci., South China Normal University); *Chin. J. Environ. Sci.*, **15**(5), 1994, pp. 43—45

A feasibility study was carried out on the use of the acidic hydrolysis two stage bacteria-added biological contact oxidation/coagulation process to treat the highly concentrated wastewater from the production process of Jiemycin. The results from this pilot study show that when the influent had a COD concentration in the range of 3500—5000mg/L and a BOD concentration in the range of 1000—1500 mg/L, there were an average COD removal of over 95% and an average BOD removal of over 96%, resulting in an effluent in compliance with the national standards for wastewater discharge under GB8978-88.

Key words: jiemycin wastewater, acidic hydrolysis, bacteria-added biological contact oxidation, coagulation and flocculation, wastewater treatment.

Study on the Role of Sulfuric Acid in the Catalytical Hydrolysis of Black Liquor from Straw Fiber Pulping Process.

Yang Runchang et al. (Dept. of

Chem. Eng., Xiangtan University 411105); *Chin. J. Environ. Sci.*, **15**(5), 1994, pp. 46—48

Sulfuric acid was found to have a catalytical function in promoting the hydrolysis of black liquor from a reed fiber pulping process. The results from this study show that under the conditions of applied pressure and heating (0.2—0.6 MPa, 130—165 °C), sulfuric acid allowed over 99% of lignin in the black liquor to be acid settled, dewatered, carbonized and then separated from the black liquor. More than 62% of theoretical aldehyde content were hydrolyzed, dewatered and then converted to furfural.

Key words: straw fiber pulping, black liquor, sulfuric acid, catalytical hydrolysis, lignin.

Study on the Degradation of Active Bright Red X-3B by Immobilized Purple Non-sulfur Photosynthetic Bacteria.

Niu Zhiqing, Wu Guoqing et al. (Dept. of Environ. Eng., Taiyuan University of Technology, Taiyuan 030024); *Chin. J. Environ. Sci.*, **15**(5), 1994, pp. 49—52

The spent dye bath of active Bright Red X-3B was treated by using aggregation and cross linkage immobilized purple non-sulfur photosynthetic bacteria (PSBs). The PSBs and their immobilized cells were compared for some of their performances. It was found that both of the cells had an optimum reaction temperature in the range of 30—40 °C, and the immobilized cells had an optimum reaction pH in the broader range of 7.5—9.4, with a better thermal stability. Cu²⁺ had an inhibitory effect on the enzyme activities of both cells. As compared with the immobilized cells entrapped in sodium alginate, the aggregation and cross linkage immobilized cells had a stronger power of decolorization, a higher activity of enzyme, a longer half lifetime and a more cost-effectiveness, and was simple to operate and easy to be applied on a full-scale.

Key words: purple non-sulfur photosynthetic bacteria, immobilized cells, decolorizing enzyme, active bright red X-3B.

Study on the Use of TFJF Model Combustion Catalyst for the Pollution Control of Waste Gases from Stoving Enamel.

Zhou Renxian, Fang Heliang et al. (Dept. of Chemistry, Hangzhou University, Hangzhou 310028); *Chin. J. Environ. Sci.*, **15**(5), 1994, pp. 53—55

TFJF Model Catalyst, a noble metal carried over a natural zeolite/cordierite honeycomb carrier, was developed and examined for its application to the pollution control of the off-gas from the stoving enamel process of enamel covered wires manufacturing. The results show that the temperature for a 98% conversion rate was 180—220 °C for aromatic hydrocarbons and 220—240 °C for cresylols. The catalyst was resistant to a temperature as high as up to 800 °C and had a better efficiency of cleaning up the gaseous wastes from stoving enamel processes. For a highly concentrated