

造纸黑液资源化清洁生产工程技术*

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摘要 造纸黑液资源化联产工程技术, 具有新颖的构思。用回收资源来治理污染, 将秸秆的利用从单一的纤维素造纸, 改造为综合利用纤维素、木质素和聚糖类资源的联产技术。本技术污染治理彻底, 将黑液各组分分离, 生产出 3 种原料产品; 二次产品开发前景广阔; 具有明显的环境效益、社会效益和经济效益。

关键词 结化, 造纸制浆, 造纸黑液, 清洁生产, 资源化, 联产。

我国 80% 的纸厂是以秸秆为原料的中小型纸厂, 造纸制浆所用的植物原料主要由纤维素、木质素和聚糖类物质组成, 造纸仅用了纤维素部分, 余下 50% 以上的天然有机资源, 在制浆蒸煮后和加入的碱一起进入废水中, 既浪费了大量资源, 又造成了严重的环境污染。

秸秆为原料的造纸黑液粘度大, 热值低, 硅含量高, 中小型规模的纸厂, 无法满足碱回收工艺连续运行的要求。酸析木质素法, 只提取了木质素, 排出的酸性废液仍然存在严重的污染。氨法造纸, 其纸质下降, 排放的含氨废水, 虽可用以肥田, 但使用数年后会引起土地的板结, 排放水的污染问题仍未得到根本解决。物理化学絮凝沉淀法, 多用于治理浓度较低的混合水, 难以处理浓度较高的黑液。

笔者开发的造纸制浆黑液资源化回收治理技术, 是一个非常简捷的技术路线, 一种新颖的技术构思, 用资源回收来治理黑液污染, 资源回收充分, 治理彻底, 无二次污染。该技术具有明显的环境效益、社会效益和经济效益。

很小的钙盐, 利用这一特性, 在酸性滤液中加入石灰, 生成钙盐沉淀, 过滤后获得钙盐产品。二次过滤后的滤液是含有聚糖类的碱性溶液, 经适当调配和浓缩生成糖矿浆或干燥后成为糖矿粉产品。

根据以上基本化学反应原理和分离步骤, 确定本技术的工艺流程, 如图 1 所示。

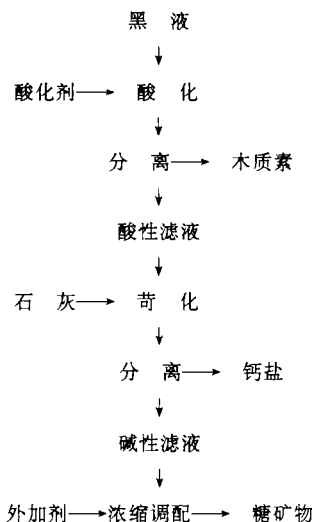


图 1 黑液资源化工艺流程示意图

1 方法原理和工艺流程

黑液含有木质素、聚糖类和钠盐 3 大成分。其中木质素具有在碱性溶液中溶解和在酸性溶液中沉淀析出的特性。本方法利用这一特性, 首先加入酸化剂将碱性黑液转化成酸性, 木质素从溶液中析出, 经过滤分离而获得木质素产品。分离木质素后的滤液, 为含聚糖类的酸性溶液, 溶液中的酸根与钙离子反应生成溶解度

2 技术特点

本方法是将造纸黑液作为资源, 以回收资

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源的方法进行黑液的污染治理。它的优势是将造纸业由单一的纸产品工业改造为纤维素、木质素、聚糖类等资源联产技术,具有十分广阔的发展前途。本方法具有以下几方面的特点:

(1) 资源回收充分 先后分别获得木质素、钙盐、糖矿物等 3 个产品。

(2) 治理彻底 黑液经本技术处理后,固形物质全部回收,无二次污染。

(3) 工艺简单 主要工序为酸化过滤、苛化过滤和浓缩调配,设备易于制作和购置。

(4) 能耗小、物耗少、投资少、经济效益好 估计日产 10 t 浆、100 t 黑液的纸厂,投资 200 余万元,从黑液中回收木质素、钙盐、糖矿物,年可获净利润 80 余万元。所得到的木质素、钙盐、糖矿物可进一步开发,获得多种二次产品,得到更大的增值。

3 前景分析

我国每年纸浆产量达到 1100 万 t,其中 800 万 t 以上,是以秸秆为原料的中小纸厂生产。本方法适合于中国的国情,开发利用制浆废液是很有前途的,可望开发成一个新兴的产业。中国的秸秆资源量干重达 5 亿 t 以上,目前已用于造纸的秸秆量还很少,该技术有广阔的推广领域。全球秸秆资源干重量可达 56 亿 t,并未得到充分的利用。秸秆资源是生长资源,是太阳和土地的产物,会年年生长出来。而石油、天然气和煤等矿物资源将在不断开采中枯竭。因此,人类为了未来持续发展的需要,将注意力转移到充分利用生长资源上来。

造纸废液中所含的木质素可作为基本的化工原料,经改性后可制成磺化木素、胺木素、硝基木素,与其它化学品合成可制成酚醛树脂、环氧树脂、聚氨脂等,木素降解可制成酚类、酸类、烃类等,可广泛地应用于农业、化工、石油、采矿业、建材业等。国内外利用木质素研制各种新产品的科研成果很多。本资源化技术使大批量木质素的生产成为现实,为各项木质素二次产品的科研成果转化为工业化生产,提供了原料供应的基本条件。糖矿粉中的低聚糖成

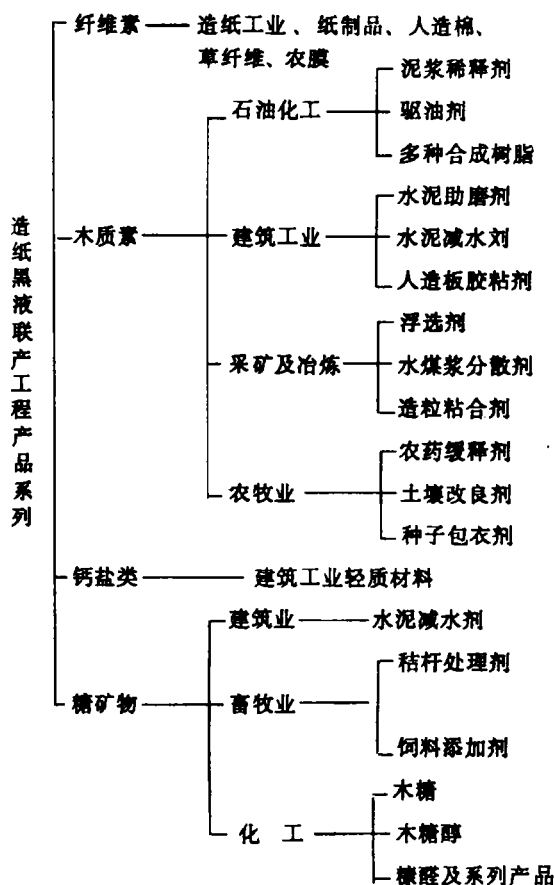


图 2 造纸黑液联产工程产品系列

分是以戊糖为主,可作为代替粮食的牲畜饲料,也可用于制备木糖、合成木糖醇、生产糠醛系列产品。钙盐是制造轻型建材的原材料,具有保温、绝热、隔音等优点(图 2)。

本技术已完成了 3000 t、5000 t、10000 t 规模的成套设计,今后拟向建立全封闭、自动化、智能化方向发展。

本研究开辟了植物秸秆高值资源化加工利用的新研究方向和领域,由笔者命之为秸化工程学,建议强化发展这一应用学科。这一新的研究领域适应了人类持续发展对资源的要求。

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Abstracts

Chinese Journal of Environmental Science

Joint Production Technology for Resource-Transfer of Paper-Making Black Liquor.

Sun Lianchao and Mu Huanzhen et al. (EIA Unit, Chinese Academy of Sciences, Beijing 100085); *Chin. J. Environ. Sci.*, **16**(4), 1995, pp. 1-2
The black liquor resource-transfer technology is an original conception. Through recovering resources to treat pollution, it transforms the utilization of straw from single cellulose paper making into comprehensive use of cellulose, lignin, glycans and other resources. At the same time, black liquor pollution is thoroughly treated without second pollution, the components of black liquor are separated and many kinds of raw materials produced. It provides a vast prospect for further development and has remarkable environmental, social and economic benefits.

Key words: joint production technology, paper making black liquor, recovering resources.

Inhibition of Sulphates and Chlorides to Anaerobic Digestion.

Wang Jusi et al. (Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, Beijing 100085); *Chin. J. Environ. Sci.*, **16**(4), 1995, pp. 3-7

The effects of sulphates (SO_4^{2-}) and Chlorides (Cl^-) concentration on the anaerobic digestion process in a batch digestion reactor were studied. The experimental results indicate that the digestion system would be normally running when the concentration of daily addition was less than 144 mg/L for SO_4^{2-} and 3195 mg/L for Cl^- and the permissible accumulated amount in the digestion system was 300 mg/L for SO_4^{2-} and 20000 mg/L for Cl^- , respectively. No inhibition effect on the anaerobic system occurred when the loading of SO_4^{2-} and Cl^- to activated sludge (dry weight) was less than 5.55 g/kg (SO_4^{2-} /VS) and 58.6 g/kg (Cl^- /VS), respectively.

Key words: sulphates, chlorides, anaerobic digestion, inhibition effects.

Relationship between Organic Acid Content in Paddy Soil and Release of Methane from It in the Red Earth Hilly Areas in South China.

Wang Weidong et al. (Changsha Institute of Agricultural Modernization, Chinese Academy of Sciences, changsha 410125); *Chin. J. Environ. Sci.*, **16**(4), 1995, pp. 8-12

Organic acid content (OAC) in paddy soil and re-

lease of methane (ROM) from it in the red earth hilly areas in South China were determined with spectrophotometry and microcomputer controlled gas chromatography, respectively. Four fertilization plots were found to have a consistent temporal trend of variation in OAC but not in ROM, and to have a correlativity between OAC and ROM as follows: the plot applied fully with organic manure ($r=0.981$) > the plot fertilized in a normal way ($r=0.855$) > the plot applied fully with chemical fertilizers ($r=0.353$) > the plot applied with a biogas residue ($r=0.0213$). Four water management plots were found to have a consistent temporal trend of variation in both OAC and ROM, except for the plot of constant moisture, and to have a correlativity between OAC and ROM as follows: 10 cm deep water covered plot ($r=0.993$) > frequently drained plot ($r=0.910$) > 3 cm deep normal water covered plot ($r=0.714$) > constant moisture plot ($r=0.00526$). OAC has the same vertical distribution in soil depth as that of ROM.

Key words: organic acid content, release of methane, paddy field, greenhouse gas.

Characterization of the Adsorption of Sulfates onto Different Types of Soil.

Kuang Qijun et al. (Institute of Hydrobiology, Chinese Academy of Sciences, Wuhan 430072); *Chin. J. Environ. Sci.*, 1995, **16**(4), pp. 13-15

The characteristics of sulfates adsorption onto the representative types of soil in the three provinces of Jiangxi, Hubei and Hunan were studied in order to further understand the effects of acid deposition on aquatic ecosystems in China, and the capacity of ecosystems in typical areas to buffer an acid deposition and their values of critical loading. The results show that the red soil, particularly from Jiangxi Province, has the strongest capacity of adsorbing sulfates with a maximum adsorption capacity of 11.52 mg/g, and others in an order of decreasing maximum adsorption capacity are yellow soil of 11.14 mg/g, brown-red soil of 8.83 mg/g, yellow-brown soil of 6.86 mg/g, yellow-red soil of 6.53 mg/g, and red-lime soil of 3.55 mg/g which is only 30% of that for red soil and the weakest one. It is expected that Jiangxi Province where red soil is dominately distributed would be one of the areas which are most sensi-