上海在建的三座大型城市污水处理厂介绍(一)
——上海石洞口污水处理厂

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提要 介绍了上海市在建的三座大型污水处理厂的基本情况:石洞口污水处理厂采用二级加强生物除磷脱氮工艺,白龙港污水处理厂采用一级加强物化法除磷处理工艺,竹园第一污水处理厂采用一级加强生物化学絮凝处理工艺;同时对三座污水处理厂的工艺流程,主要设计技术参数及污泥处理,总工程造价等进行了说明。

关键词 城市污水处理厂 除磷脱氮 污泥处理 工艺流程 上海市

0 前言

按照上海市污水系统专业规划,目前,上海市正在建设三座大型城市污水处理厂,即石洞口、白龙港与竹园第一污水处理厂(位置示意见图1)。

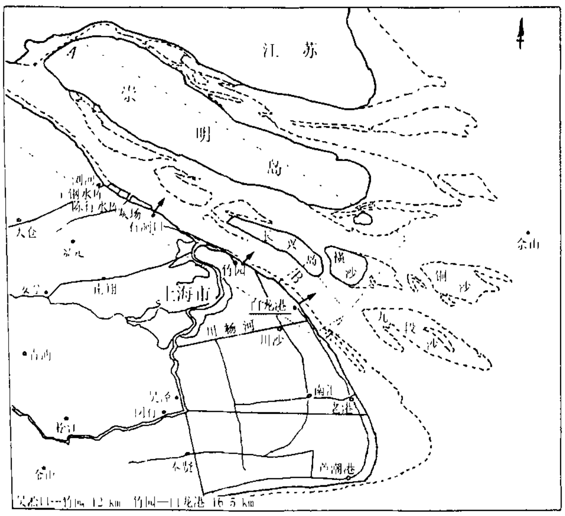

图1 石洞口、白龙港、竹园位置示意

石洞口污水处理厂规模40万m^3/d,采用二级加强生物除磷脱氮处理工艺;污泥采用浓缩、干化、焚烧工艺。建设资金来自中央及地方投资、部分亚洲开发银行贷款。白龙港污水处理厂规模120万m^3/d,采用一级加强物化法除磷处理工艺;污泥采用储泥池、脱水、卫生填埋,最终作绿化介质土。建设资金来自中央及地方投资、部分世界银行贷款。竹园第一污水处理厂规模170万m^3/d,采用一级加强生物化学絮凝处理工艺,污泥采用浓缩、脱水、卫生填埋,最终作绿化介质土。建设资金来自民营投资。

三座污水处理厂处理城市污水量约330万m^3/d,与2020年中心城规划污水量基本相等。在工程布置中,已考虑白龙港与竹园第一污水处理厂处理程度可以进一步提高。

现把三座污水处理厂主要内容分3次介绍,供读者参考。首先介绍石洞口污水处理厂。

1 简况

1.1 处理厂位置

上海石洞口污水处理厂位于宝山区盛桥镇长江边,原西区污水总管出口处,东侧为石洞口煤气厂,西邻罗泾煤码头,北靠长江。处理厂规划用地面积66.17hm^2,一期工程用地面积28.2 hm^2。

1.2 污水收集系统

利用已建成的西区污水总管收集城市污水,该总管长23.2 km,设5座中途泵站,转输提升后进污水处理厂。污水收集范围,苏州河支流污水截流北片地区,宝山区,南翔镇以及市区西北部,按照市2001年污水规划,石洞口污水系统服务面积79.16 km^2,人口93.16万,污水量40万m^3/d。

1.3 处理厂尾水排放点

经污水处理厂处理后,尾水达到一级排放标准后,采用岸边水下排放方式,排入长江。

建设单位:上海市苏州河综合整治建设有限公司;

设计单位:上海市政工程设计研究院;

施工单位:共分17个标,分土建、设备、电气等

通过竞争招标,选择承包商。

2 工程规模及技术标准

2.1 工程规模

设计平均日污水量 40 万 m^3/d,高峰污水量 6.018 m^3/s;现状污水量 19～24 万 m^3/d。

2.2 污水水质

污水性质:分流制污水,其中工业废水约占 40 %,生活污水占 60 %,进处理厂污水水质及处理厂出水水质见表 1。

表 1 污水处理厂进出水水质

项目	COD / mg/L	BOD / mg/L	SS / mg/L	NH_3 - N / mg/L	TP / mg/L
进水	400	200	250	30	4.5
出水	≤60	≤20	≤20	≤10	≤1.0

2.3 污泥处理及处置

采用浓缩、脱水、干化、焚烧方案,焚烧后灰外运填埋。

3 污水、污泥处理工艺

3.1 污水处理工艺流程(见图 2)

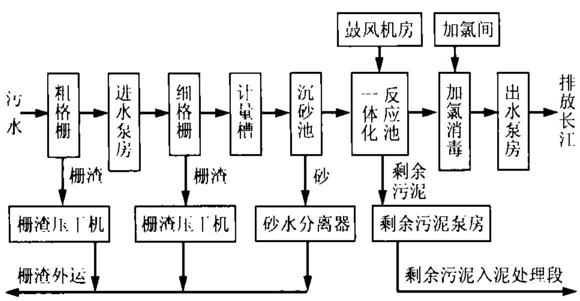

图 2 污水处理工艺流程

3.2 污水处理主要技术参数

污水处理主体构筑物为一体化反应池,即曝气/沉淀均在同一座水池中,生物除磷脱氮主要参数如下:

污泥负荷:0.11 kgBOD/(kgMLSS·d);污泥浓度:4 kg/m^3;水力停留时间:15.9 h;反硝化率:0.047 kgNO_3^- - N/(kgMLSS·d);供氧量:133 000 kgO_2/d;气水比:1∶7.3。

沉淀部分的水力负荷:1.13 $m^3/(m^2 \cdot h)$(斜板);出水堰负荷 1.24 L/(s·m)。

3.3 一体化反应池描述

一体化反应池共 4 座,每座分 3 槽,每槽由 3 格矩形水池组成,每格平面尺寸 35 m×35 m,有效水深 6 m,每格之间有 *DN*1 000 管道连通,运行时,每 3 格可处理污水 3.33 万 m^3/d。3 格水池底部均布置曝气扩散装置,搅拌设施,两边格上部布置斜板及出水槽。若左边格进水,经中间一格至右边格,该边格作沉淀池,处理水经斜板后出水,左边格及中间格按厌氧、缺氧、好氧顺序工作。经一周期后,从右边格进水,此时左边格作沉淀池,处理后出水,这样反复运行。与已建成的三槽式氧化沟运作情况相同。

3.4 污泥处理

污泥处理量:干泥 64 t/d,采用污泥处理与处置工艺,见图 3。污泥处理工艺主要设计参数如下。

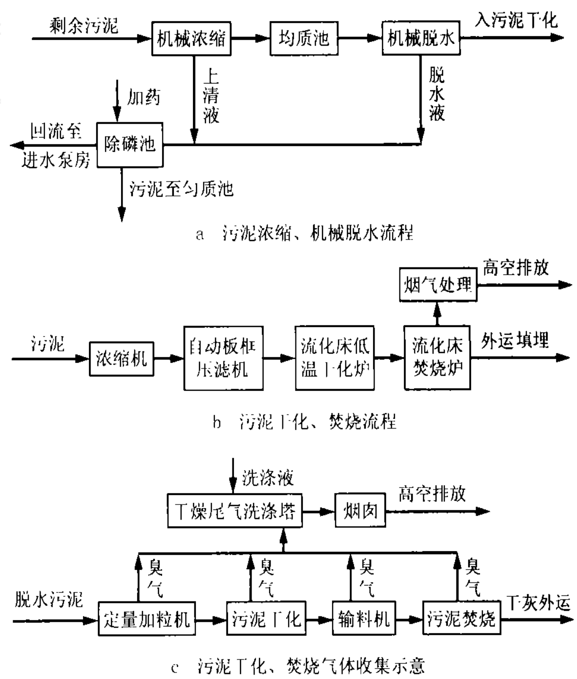

图 3 污泥处理与处置工艺流程

3.4.1 污泥浓缩机

选用螺旋压榨式污泥浓缩机 6 台(5 用 1 备),单台工作能力 60～100 m^3/h,功率 3 kW,工作 16 h/d,另带投药系统。

3.4.2 污泥脱水机

经比较选用带压榨机构的滤布固定式凹板型压滤机 2 套(1 用 1 备),滤板尺寸 1.5 m×1.5 m,过滤面积 409 m^2,工作能力 105 m^3/h,进泥含水率 97 %,出泥含水率 75 %以下,另有投药系统。工作时间 22 h/d。

3.4.3 污泥干化与焚烧处理

污泥干化方式,采用流化床干化法,或盘式干化塔法,均系成套系统组成。主要由湿污泥进料及储存系统,湿污泥输送装置,破碎加料机,流化床干燥器或盘式干化塔,干污泥输送装置,干污泥储存器,混合器,惰性气体循环净化系统,以及蒸汽供应,冷凝水回收系统等组成。若以流化床干燥器为例,其技术规格为:水分蒸发能力 9.4 t/h,供应蒸汽参数为 1.2 MPa 饱和蒸汽 12.8 t/h。

污泥焚烧装置,采用污泥循环流化床焚烧方法,本装置包括焚烧及余热回收系统,烟气净化排放系统和排渣出灰系统。来自干化装置的污泥,由干化污泥贮仓内,经计量泵送至焚烧炉中部,通过加料机加入到炉内,污泥进入炉内后,水分蒸发而发生爆裂,形成污泥碎屑,在流化状态下干燥进而开始燃烧,污泥放出的热量可以促使污泥稳定燃烧。

进干化炉和焚烧炉污泥参数:处理量 64 t/d,湿泥 213 m^3/d,干化后污泥含水率为 10 %。

湿泥含水率为 70 %,低位发热量 14.88 MJ/kg。

污泥干燥机 1 套。

循环流化床焚烧炉 3 台,处理量必须保持在 50 %~100 %范围内正常运转,即 102~213 t/d,正常工作时间 8 000 h。

补充燃料(重油) 68.8 kg/h,单台燃烧空气量 16 223 m^3/h,过量空气系数 1.3,单位烟气量(冷却后) 18 096 m^3/h(标准状态),单台出渣量 1.5 t/h,燃烧温度 850~900 ℃,预热空气温度 650 ℃,最终排烟温度 163 ℃,灰渣排量 625 kg/h。运行消耗:电耗 731 kW,重油 2.3 t/d,浓度为 48 %的 NaOH 溶液 98.6 kg/h,硅砂 1.5 t/d。

3.4.4 污泥水处理

污泥浓缩、脱水产生的污泥水约 7 744 m^3/d,采用投加石灰、沉淀处理工艺,污泥水处理工艺流程见图 4。

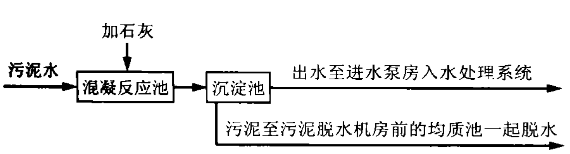

图 4 污泥水处理工艺流程

3.5 处理厂回用水处理工艺

处理厂回用水量 80 m^3/h,回用水水质见表 2。回用水处理工艺见图 5。

表 2 回用水水质

项目	COD /mg/L	BOD /mg/L	SS /mg/L	NH_3-N /mg/L	TP /mg/L	pH	臭
二级处理出水	60	20	20	10	1.0	6~9	
回用水水质	≤50	≤10	≤10	≤8	-	6.5~7.2	无不快感觉

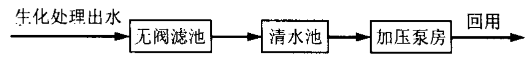

图 5 回用水处理流程

4 工程造价及建设进度

4.1 工程造价

初步设计工程造价 8.732 7 亿元(包括污泥处理和前期费用);单位处理成本 0.76 元/m^3(包括污泥处理)。

4.2 建设进度

1998 年 9 月通过"上海市石洞口污水处理厂工程总体方案设计"征集,上海市政工程设计研究院中标,承担工程设计;

1998 年 10 月编就"上海市石洞口污水处理厂工程可行性研究报告";

1999 年 6 月上海市计划委员会批准可行性研究报告;

1999 年 7 月编就上海市石洞口污水处理厂工程初步设计;

1999 年 12 月上海市建设委员会批准初步设计;

1999 年 12 月开始分批招标;

1999 年 12 月底开工,计划在 2002 年 12 月投产试运行。

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ABSTRACTS

Abstract: As a large-scale waterworks designed and constructed by ourselves, Changqiao Waterworks was inchoate since the years of so called Great Leap, the late of 1950s, and now it has capacity of 1.6 million cubic meters per day, the largest one in this country. At the beginning the earth-dammed horizontal sedimentation tank was adopted to save costly materials and also the big-diameter non-metal pipes were applied for this project at first in this country. In the continued reconstructions of this waterworks, an underground clear water tank was piled up just under the sedimentation tank to reduce the space requirement and capital investment. Besides these also the movable backwashing bell mantel and biggest pumping assemblies (pump and motor) were used.

Abstract: Three large-scale wastewater treatment plants are under construction in Shanghai. There are the Shidongkou WWTP of strengthening secondary biological treatment process with P and N removals, Zhuyuan First WWTP of strengthening primary physico-chemical process with P removal and Bailonggang WWTP of strengthening primary bio-chemical flocculation process. The details including the technological processes, design parameters, sludge disposal and investments of these three are presented.

Abstract: On the basis of so-called theory of limiting factor, the removal efficiency of organic matters in biological filters for drinking water treatment could be increased significantly by addition of phosphate to the inflow of the filter. Before the addition of phosphorus, two parallel biological filters (BF1 and BF2) removed 14.13% and 16.49% of COD_{Mn} respectively; after P addition to BF1, the removal rate of BF1 reached 20.56%, which was 6.02 percentage points higher than that of the control tank BF2. When the dosage of P was lower than 20 μg/L, the soluble P in the outlet of BF1 was 12.88 μg/L, lower than 13.69 μg/L in the raw water, thus no phosphorus pollution occurred. The removal efficiency of organic matters of BF1 had a good linear correlation with the utilization of phosphorus by the microbes. The difference of the phosphate removal between P dosed BF1 and control BF2 was 4～12 μg/L, the former could remove 55.3 μg/L of COD_{Mn}, it is 1.43 percentage points higher than the later as it removed 1 μg/L of phosphorus more than later.

Abstract: Phosphorus and its compounds are non-renewable and non-replaceable limited resources. Biological nutrient removal for eutrophication control creates a prerequisite for phosphorus recovery. Recovered phosphorus substances as struvite etc. by way of phosphate sedimentation could be recycled as fertilizers or for use in industry, which has became a hot topic in the world. Based on the ideas and conclusions from the second international conference on phosphorus recovery from sewage, this article presents basic idea, field experience, sludge management, technical perspective, economic analysis, etc. for phosphate recovery.

Abstract: Organic substances shall be removed effectively in denitrification processes using granule filter bed, bio-membrane process with elastic material package or suspended activated sludge process, and all of their the volume removal load is more than 2.0 kgCOD/(m^3·d). In comparing of these three processes in aspects of process stability, degree of denitrification and reaction kinetics rate constants, it is found that granule filter bed and activated sludge process are better than elastic packaged bio-membrane. And also it is suggested that granule filter bed might be more suitable for water supply and activated sludge process for wastewater treatment respectively.

Abstract: Egg-Shape Plate Separator (EPS) is a kind of oil-water separators, which has advantages of high removal efficiency, large removal capacity and easy to operate and maintain, also the operating expense is low. By using it, the disadvantages of plate separator such as higher oil residue in outflow and poor removal of high-density oil can be overcome. The best oil removal of EPS can reach to 99%. It has been applied in many oil wastewater treatment projects home and abroad with fair results.

Abstract: FeC and catalytic oxidation pre-treatment + A/O biological processes are adopted to treat trade waste-water discharged from a chemical plant in Lishui, Zhejiang Province. Designed facility with overall capacity of 1 500 cubic