International Journal of Latest Research in Science and Technology **ISSN (Online):2278-5299**
Vol.1,Issue 2 :Page No.76-79 ,July-August 2012
https://www.mnkpublication.com/journal/ijlrst/index.php

COMMISSIONING AN INDUSTRIAL WASTE WATER TREATMENT SYSTEM IN CHINA

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Abstract - China is one of the world's largest producers of industrial waste water. Insufficient treatment has resulted in large scale environmental pollution with hundreds of cities facing inadequate access to clean water. China's local, municipal, provincial, and ministerial governments have responded by increasing waste water regulations. International manufacturers, unfamiliar with these rules, risk project delays, cost overruns, and forced production stoppages. To prevent such problems, this paper answers 3 questions. "What are China's regulations on industrial waste water discharge?" "What approvals are needed for a factory in China to set up a waste water treatment station?" And, "What does it cost a factory to meet China's waste water disposal requirements?"

Keywords- China, Waste water, Discharge regulations

I. INTRODUCTION

China accounts for approximately 5% of the world's annual waste water generation [1]. Between 2004 and 2008, annual wastewater discharge in China increased by 18 % (i.e. from 48.2 billion to 57.2 billion metric tons [2]). With treatment unable to keep pace, 75% of China's lakes are significantly polluted [3] and 400 Chinese cities face inadequate access to clean water [4]. The response from local, municipal, provincial, and ministerial governments has been increased waste water regulation. International companies setting up factories in China, unfamiliar with these laws, run risks of project delays, cost overruns, and forced production stoppages. To prevent such problems, this paper answers the question, "What are the regulations, approvals, and costs for a factory in China to commission a waste water treatment station?"

II. REGULATIONS

Under China's *Environmental Protection Law*, before production can begin, a factory is required to file an *Environmental Impact Assessment* (EIA) report with the local Environmental Bureau (EB). The EIA is written by a local EB "approved" firm and describes the manufacturing operation's effect on baseline environment. Baseline soil and groundwater contaminate levels are determined by a local EB "approved" environmental site assessor.

According to the *Implementation Regulation of Water Pollution Prevention and Control Law* [3] to dispose of waste water a factory must have a discharge permit. The type of permit depends on waste water chemistry and amount being discharged. China National Standard GB 8978-1996 describes waste water chemistry using 56 parameters. Those applicable to most manufacturers include:

- pH = A logarithmic scale of acidity (<7) through alkalinity (>7)
- TSS = Total Suspended Solids
- COD = Chemical Oxygen Demand measures all chemicals in the waste water which can be oxidized using strong chemicals [5])
- BOD_5 = Biochemical Oxygen Demand is the amount of organic carbon in the waste water which bacteria can oxidize over a five day period [6])
- NH_3-N = Ammonia Nitrogen
- LAS = Linear Alkylbenzene Sulfonate is a surfactant commonly found in detergents [7]
- Oil

Table I classifies waste water according to the above parameters.

TABLE I EXCERT OF GB8979-1996 FOR ALLOWABLE WASTE WATER DISCHARGE

Type	pH	TSS	COD	BOD_5	NH_3-N	LAS	Oil
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Level 3	6 to 9	400	500	300	-	20	20
Level 2	6 to 9	⩽150	⩽150	⩽30	⩽25	⩽10	⩽10
Level 1	6 to 9	⩽70	⩽100	⩽20	⩽15	⩽5	⩽5

If discharge will not exceed 500 metric tons/day and COD will not exceed 0.5 metric tons/day, the local EB is authorized to issue the discharge permit. Otherwise, the permit needs to be issued by the Provincial EB.

A factory's water discharge level is specified in the EIA. Permissible chemistry depends where waste water is sent and where the factory is located. For example, if waste water is being pretreated at the factory for disposal to a city water treatment center level 3 is generally sufficient. If discharge is sent to a fresh body of water (i.e. lake, river, pond, or stream) level 2 or 1 is needed. It is important to recognize local regulations and standards may be stricter than the national

Publication History
Manuscript Received : 10 August 2012
Manuscript Accepted : 25 August 2012
Revision Received : 28 August 2012
Manuscript Published : 31 August 2012

GB level. In which case, the factory's EIA specifies the tighter of the two.

The local EB periodically (i.e. every 3 months) measures waste water discharge against specifications in the EIA. Analysis may be done by the local EB or an "approved" outside lab. If findings exceed EIA limits, the local EB has the authority to issue fines and request on site monitoring. Monitoring equipment is sought when any one of the following is true:

- Discharge is greater than 100 metric tons/day or COD exceeds 30kg/day.
- Discharge is found by the local EB to exceed allowable limits 2 times
- The factory is directed by provincial, city, or local government to reduce pollutants

Monitoring equipment is regulated. It must be (a) approved by the local EB, (b) regularly calibrated by the Quality Assurance Bureau, and (c) linked with the local EB for automatic data collection.

Regulation of waste water equipment is not confined to measurement technology. Treatment system designs are also regulated. Due to poor quality domestic membrane filter technology in China, gravity based treatment systems predominate [3]. Gravity systems leverage the fact particles suspended in water normally carry surface charges [8]. By pumping in coagulants these charges neutralize causing contaminates to bind. Mixing in flocculates enlarges and strengthens these bonds speeding up separation. To meet required oxygen (O_2) levels in waste water discharge, anaerobic bacteria are used. Bacteria digest organics in waste water thereby releasing O_2. Gravity based treatment systems are straight forward enough any number of designers in China can quote. However, only those holding an Environmental Pollution Control license are authorized to do so. Additionally, if waste water treatment exceeds 500 metric tons/day and COD exceeds 0.5 metric tons/day, designers must hold either a class "A" or "B" license. These design licenses are issued by the Provincial Construction Bureau. Otherwise, a class "C" design license issued by the local Construction Bureau is sufficient.

Besides regulating treatment system design, governmental authorities also control waste water equipment operation. If discharge exceeds 50,000 metric tons/day, an "A" operating license is required. This license is issued by the Ministerial Environmental Protection Administration. At lower discharge levels a "B" operating license (issued by the Provincial Environmental Protection Administration) is needed.

Regulations on waste water discharge extend off a factory's site to include disposal of solids. The *Management Regulation for Hazardous Waste Transfer Manifests* requires trucking firms to be licensed by the Traffic Bureau. The license specifies what types of waste can be transported and where it can be disposed. According to the *Solid Waste Pollution Prevention and Control Law*, disposal sites must be licensed by the Provincial EB. The local EB administrates this process. For example, the factory, trucking firm, and disposal site must place their company stamps on solid waste transfer manifests. Manifest records of dates and weights are maintained at the factory, trucking firm, disposal site, and local EB.

III. APPROVALS

To commission a waste water station in China requires a series of governmental reviews. These consist of: 5 assessment reports, 2 permits, and approvals from 13 governmental agencies. Table II breaks approvals down by document, approver and approximate time needed.

TABLE III STEPS TO COMMISSION A WASTE WATER TREATMENT STATION

Document	Approver	Days to Approve
Feasibility Report	EDB	30
Preliminary Design	Factory Engineer	20
Energy Assessment Report	EDB	25
Safety Assessment Report	Municipal Admin. Of Worker Safety	20
EIA Report	EB	25
Geological Investigation Report	Local Planning Bureau	30
Final Design	Factory Engineer	30
Local Land Use & Construction Permits	Local Planning Bureau	30
Installation Design Review	Local Planning Bureau	80
	Municipal Construction Bureau	
	Municipal Drawing Audit Center	
	Fire Bureau	
	Water Bureau	
	Power Bureau	
	Municipal Admin. Of Worker Safety	
	Quality Admin. Bureau	
	Urban Admin Bureau	
Provincial Construction Permit	Provincial Planning Bureau	30
Construction	Supervision Company	20
Post Installation Review	Local Planning Bureau	180
	Municipal Construction Bureau	
	Municipal Drawing Audit Center	
	Fire Bureau	
	Water Bureau	
	Power Bureau	
	Municipal Admin. Of Worker Safety	
	Quality Admin. Bureau	
	Urban Admin Bureau	
Survey Report	Local Planning Bureau	30
Provincial Land Use Permit	Provincial Planning Bureau	30

Per Table II, approval starts with submitting a *feasibility report* to the local Economic Development Bureau (EDP). The report must be written by an EDP "approved" firm. The EDP evaluates whether the waste water treatment station fits (a) national industrial policy and (b) local industrial policy.

If the *feasibility report* additional assessment reports are submitted.

An *energy assessment report* is provided to the EDB. This report quantifies the waste water station's energy requirement. Energy needs are weighed against local energy policies.

A *safety assessment report* is provided to the Municipal Administration of Work Safety Bureau. Safety and reliability analysis of treatment equipment are done. Hazard factors are detailed and risk levels assessed.

A *geological investigation report* is needed for the exact site of the waste water station. Topographical maps are made. Past uses of the land are investigated. And, soil tests (i.e. strength, contaminants, minerals, hydrology, etc.) are performed.

If the EIA and assessment reports are approved, the local Planning Bureau performs a preliminary design review. If approved, 2 permits are issued. One is for land use and the other is for construction.

At this point the treatment equipment designer submits installation drawings to the Municipal Construction Bureau and Drawing Audit Centre. If approved, designs are provided to 6 additional bureaus for review:

- Fire Bureau
- Water Bureau
- Power Bureau
- Worker Safety Bureau
- Quality Administration Bureau
- Urban Administration Bureau

If the above bureaus sign off, installation designs are provided to the Provincial Planning Bureau for a construction permit. After construction is complete, the above 6 bureaus must approve the installation. After which, a municipal survey is done and the Provincial Property Bureau issues a land use certificate.

Per Table II, it takes approximately 1 year to commission a waste water treatment station in China. Delays are likely considering approvals must be done sequentially and 85% of time to set up a system involves approvals. International companies unfamiliar with local policies and bureaucracies may elect to hire a local EB "approved" project management firm.

IV. Costs

The purchase price of a waste water treatment system depends on 3 factors – treatment method, water cleanliness, and capacity. Generally speaking, the price for a Chinese-made, gravity based system discharging level 3 waste water is 75,000 rmb/metric ton of water treated daily. Finding a licensed vendor to sell such a system should not be a problem considering 300 Chinese design institutes are involved in wastewater treatment. And, several hundred factories produce wastewater treatment equipment and materials [4].

Costs to operate a treatment system depend on 3 factors – discharge, treatment, and disposal. The local EB assesses a factory generating wastewater a discharge fee. Depending on factory location, the fee varies from 0.125 to 0.44 rmb/metric ton of waste water [3]. Discharge cost, however, pales in comparison to treatment cost. For a gravity based system treatment averages 17.34 rmb/metric ton of waste water (Table III).

TABLE IIIII WASTE WATER TREATMENT COSTS

Item	Name	Unit Price	rmb/metric ton of waste water
1	Labor	1800 rmb/person/month	5.5
2	Electricity	0.65 rmb/Kwh	8.3
3	City water	2.5 rmb/metric ton	0.24
4	NaOH	1800 rmb/metric ton	1.09
5	H_2SO_4	1500 rmb/metric ton	0.13
6	PAC	1500 rmb/metric ton	1.87
7	PAM	25000 rmb/metric ton	0.21
Total			17.34

Per Table III, labor and electricity drive treatment costs. Treatment costs, however, are only a fraction of disposal costs. Depending on factory location, disposal costs average 2,500 rmb/metric ton of solid waste. With gravity based treatment systems generating on the order of 35 kg solid waste per ton of waste water, disposal costs in China average 87.5 rmb/metric ton of waste water. Disposal cost drives waste water treatment costs.

V. Conclusions

The Chinese regulatory system for industrial waste water encompasses measurement, design, construction, equipment operation, and disposal. It can take upwards of 1 year for a factory to receive all necessary approvals to set up waste water treatment system. Even with all of these rules, 1 major infraction occurs every 2 days in China [9]. Manufacturers have elected to forgo regulations, discharge illegally, and pay the penalty if caught. Such practices can be explained under the previous *Collection and Management Provisions of Pollutions Discharge Fee (State Council, 2003 Order No. 31).* Fines were orders of magnitude lower than costs to operate waste water treatment systems [10].

Recent amendments to Chinese environmental laws seek to address noncompliance. Under a 2008 revision to the *Law of the People's Republic of China on Prevention and Control of Water Pollution* serious incidents are now fined at 30% of direct damages with no upper limit [11]. No upper limit has taken on additional deterrence. For the first time in China those affected by pollution can file class action lawsuits.

How well government regulations translate into water protection remains to be seen. As explained in this paper, local bureaus oversee environmental protection. Local bureaus report to the local Economic Development Bureau. The EDB relies upon local industry for tax revenue.

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