Hybrid Lagoon System

-New Biological Wastewater Treatment System-

to achieve the Council Directive 91/271/EEC concerning urban wastewater treatment and to protect water resources in Europe

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http://www.rera.org webmaster@rera.org

Rural Environment Research Association

Rural Environment Research Association ("RERA") is an environmental NGO founded by Dr. Jun Ui and Mr. Hiroshi Kishi in 1976. Under RERA's fundamental principle, "Construct societies in that any of human constructs never harm people nor destroy environment", RERA has developed a new biological wastewater treatment technology called "Hybrid Lagoon System" ("HLS") to protect limited water resources around the world.
HLS has been adopted in over 200 projects to provide higher quality wastewater treatment and lower energy consumption that any prior technologies cannot achieve.

Hybrid Lagoon System ("HLS")

HLS, a new biological technology, is to achieve the highest quality of nitrogen removal and energy saving by optimising functions of activated sludge treating wastewater with a combination of new hardware and new software. HLS has been authorised by the Japan's government and was patented in Japan (4146491) and the United States (US 7,585,414 B2) through PCT patent application processes in Europe. For HLS, RERA made its presentation to the US-JAPAN Expert Meeting in 1991 and ICCS EU Rotterdam on September 1997.

	Hybrid Lagoon System	Prior art Technologies
1. Treatment method	Batch wise method	3-steps continuous method
2. System	Simple	Complicated
3. Reactor's shape	Inverted circular truncated cone	Box or Cylinder
4. Water facility	Complete mixture	Turbulent or Incomplete mixture
5. Nitrification and nitrate respiration	Symbiosis Separated for each states.	Separated for each states
6. Functions of micro-organisms	Visualised	Dynamic analysed
7. Standard of treatment	Less than T-N 5mg/l for urban wastewater	Depend on an administrator of the system
8. Nitrogen removal (Percentage of gasification of nitrogen in wastewater)	90-95% as an extraction ratio of T-N	?
9. Way against changing of quantity of wastewater and any turbulences	Optimising the volume of aeration	Depend on an administrator of the system
10.Way against seasonal changing	Optimising the volume of activated	No way
11. Chemicals Not needed Needed	Not needed	Needed
12. Remoto controlling	Possible	Not possible
13. Controlling functions of micro-organisms	Non-mathematical algorithm	Depend on an administrator of the system
14. Treatment for highly concentrated wastewater	90-98% as an extraction ratio of T-N without diluting	Impossible
15. Improving hazardous bottom sediment in closed water system	Possible	Impossible

Current Situation of water resources in Europe

In 1991, the European Council enacted the Council Directive 91/271/EEC concerning urban wastewater treatment to resolve eutrophication and nitrogen contamination in water resources such as lakes, rivers, dams, and groundwater and has obliged 27 EU member states to implement required regulations by 2000. However, according to the 7th Implementation Report on the Urban Waste Water Treatment Directive published by the European Council, many cities, capitals, and even member states have not met the required regulations.

In this exhibition, as our new biological treatment technology to complete targets of the regulations for environment in Europe that have been previously unachievable by prior biological treatment technologies and even to reduce 50% of energy required for denitrification treatment and emission of greenhouse gases,

RERA will introduce and propose "Hybrid Lagoon System" to you.

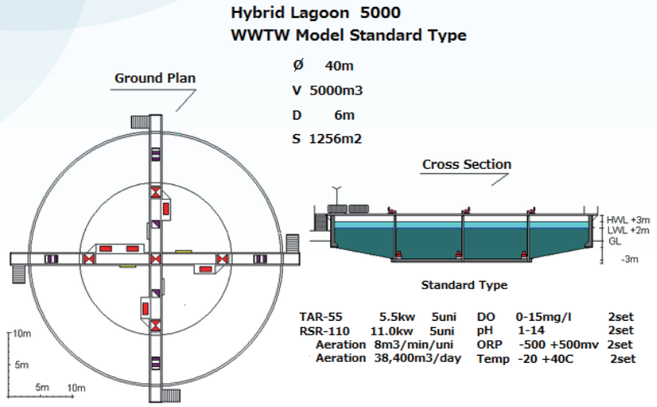
With some examples below, HLS has been adopted to many facilities in Japan.

Advanced Treatment Plant for Domestic Wastewater
(not categorised by Former Ministry of Health & Welfare)
30m diameter / 8m water depth / effective capacity 3000 m^3

Advanced Treatment Plant for Domestic Wastewater
(Air Temperature - 15°C / Water Temperature 0°C)
90% nitrogen removal / MLSS 5000mg/l

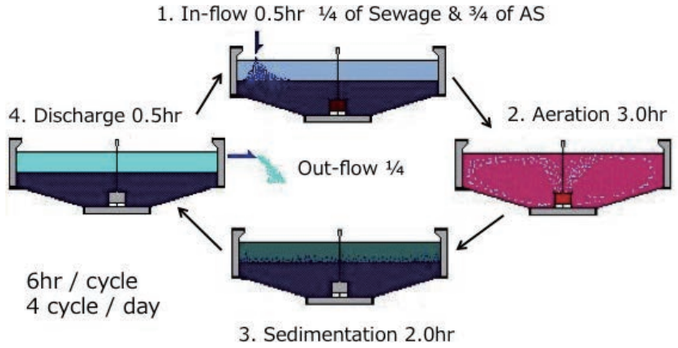
Full View and Internal Structure of Several Wastewater Treatment Plants under HLS

HLS's New Hardware

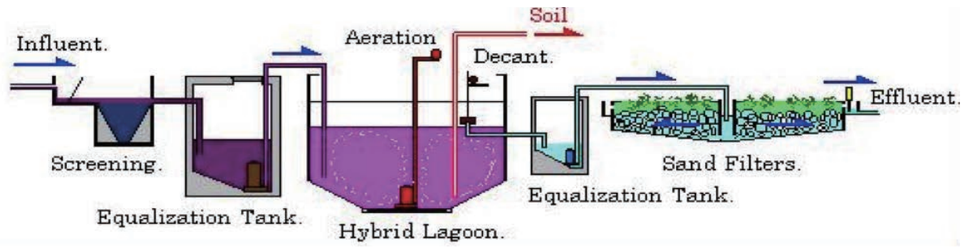


The hardware of HLS constitutes a single reactor with inverted circular truncated cone shape.

In the reactor, a variety of microorganism coexists and the microorganism performs denitrification treatment.
This shape enables to stir microorganism and wastewater uniformly and to control power for aeration.



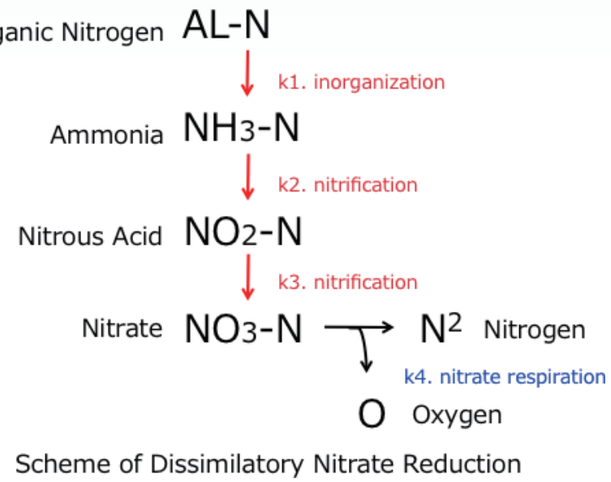
In the reactor, 4 steps of (1) in-flowing, (2) aeration, (3) sedimentation, and (4) discharge are repeated endlessly for wastewater treatment.



HLS does not require any tanks for return, circulation, or final sedimentation of activated sludge. This means that HLS can make a flow sheet for a wastewater treatment plant simpler.

HLS's New Software

Prior technologies for wastewater treatment constitute hardware only without any software technology to perform automatic controlling. HLS is a combination of the single reactor as the new hardware and the new software under a non-mathematical algorithm theory. By the combination, although quality and a quantity of inflowing wastewater fluctuate or even water temperature drops, quantity of supply of oxygen and microorganism in the reactor can be adjusted automatically. This means that a stabilised function for biological denitrification can be maintained and, therefore, 90% of nitrogen in wastewater can be removed.



Scheme of Dissimilatory Nitrate Reduction

A reaction path of nitrogen in wastewater is too complex to be predicted by calculation.
However, life reaction has strict regularities,that is, algorithm.
The new software is based on this non-mathematical algorithm theory.

The new software consists of 7 multi-layered steps for a variety of microorganism with many different functions to acclimate and coexist in the single reactor and to control denitrification reaction automatically. These steps and other functions enable to optimise an amount of oxygen and supply for the functions of microorganism that always fluctuate and its oxygen demand and, therefore, 2 different functions of nitrification and denitrification of microorganism can coexist in the single reactor. Through the idea, HLS can achieve high-quality wastewater treatment and low energy consumption.

Data of water quality in several wastewater treatment plants under HLS

The data of water quality below filed and examined for the patent application of PCT IB 2005-00252 for HLS. The data show from values of minimum, maximum, average and standard deviation of qualities of influent water and decontamination ratio from the influent water of 3 plants selected from wastewater treatment plants under HLS with official authorisation number ("BCJ number") from Japan's government. These analysis tables of water quality are subject to an analysis method for sewage water adopted in Japan. Several third-party subcontractors designated from Japan's local governments sampled and analysed for the tables.

Table 1. Sewage treatment plant BCJ-2355 1995/8-1996/9 n=12* 1 m³ /0.225kWh

Item		Flow -in				Flow -out				Removal
Unit		Max	Mini	Ave	STD	Max	Mini	Ave	STD	Ave
BOD 5	mg/l	830	71.0	225.5	219.3	7.9	0.5	2.7	2.1	98.8%
COD Mn**	mg/l	-	-	-	-	-	-	-	-	-
Total -N***	mg/l	156	13.0	44.9	36.6	4.3	1.1	2.4	2.1	94.8%
Total -P	mg/l	44	3.1	8.4	11.3	3.2	0.9	2.2	0.8	73.8%
SS	mg/l	2800	72	369	768	6.4	1.8	3.4	1.8	99.1%
Temp.	°C	25.1	9.8	18.5	-	29.5	15.6	24.1	-	-
MLSS	mg/l	-	-	-	-	6100	2000	4008	1226	-

Table 2 Sewage treatment plant BCJ-1850 1991/8-1993/6 n=12

Item		Flow -in				Flow -out				Removal
Unit		Max	Mini	Ave	STD	Max	Mini	Ave	STD	Ave
BOD 5	mg/l	260.0	85.0	190.8	56.8	2.9	0.7	1.6	0.7	99.1%
COD Mn	mg/l	96.0	49.0	77.3	15.9	9.2	5.4	7.4	1.0	90.5%
Total-N	mg/l	50.5	25.0	37.0	7.4	3.8	1.8	2.9	0.8	92.1%
Total-P	mg/l	8.6	4.6	5.9	1.4	2.23	0.43	1.25	0.51	78.8%
SS	mg/l	222.0	40.0	136.6	52.8	9.9	0.1	1.5	2.7	90.8%
Temp.	°C	31.8	6.3	18.5	-	26.6	13.5	20.0	-	-
MLSS	mg/l	-	-	-	-	5160	2600	3578	869	-

Table 3. Sewage treatment plant BCJ-1560-1 1994/4-1995/3. n=12

Item		Flow -in				Flow -out				Removal
Unit		Max	Mini	Ave	STD	Max	Mini	Ave	STD	Ave
BOD 5	mg/l	227	133	205	42	2.1	0.3	1.2	0.4	99.4%
COD Mn	mg/l	240	68	136	21	14.0	4.2	6.7	0.6	95.0%
Total -N	mg/l	58.8	34.4	45.2	27.3	5.3	0.6	2.3	0.6	94.0%
Total -P	mg/l	6.11	3.60	4.98	1.15	2.54	0.13	1.34	0.45	73.0%
SS	mg/l	561	64	158	44.9	5.0	0.4	1.1	2.3	99.3%
Temp	°C	-	-	-	-	21.8	7.2	13.9	-	-
MLSS	mg/l	-	-	-	-	4618	2130	3058	521	-

* "n=12" means that samples of water for examinations were collected 12 times per a year (month).
** "Mn" means Mangan. This means the way of measurement of COD by using potassium permanganate.
*** "Total-N" means total nitrogen.

Two Proposals from HLS

Proposal 1: New urban wastewater treatment plant under HLS

The figure below shows a set of facilities for a wastewater treatment plant for 200,000 persons and 20,000 tons of inflowing wastewater per a day.

Sewage & Human Waste Treatment Plan

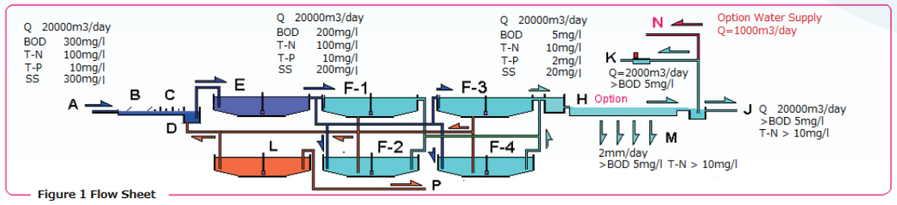


Figure 1 Flow Sheet

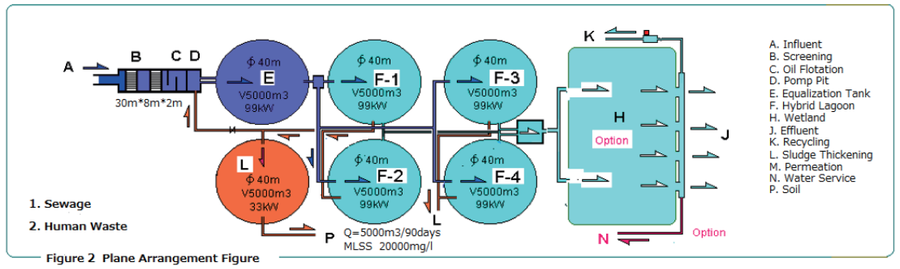
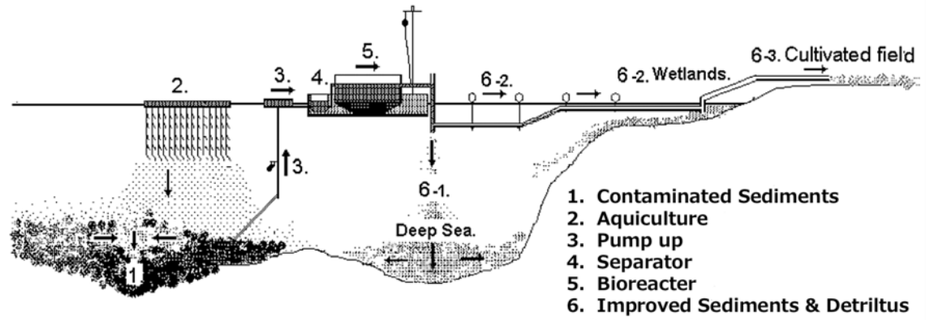


Figure 2 Plane Arrangement Figure

Proposal 2: Process for direct cleanup of lakes

By HLS, physical properties of contaminated bottom sediment on polluted water areas can be improved and transformed into sludge containing plenty of oxygen. By releasing the improved sludge into the polluted water areas, oxygen in the bottom can be supplied and maintained and, therefore, eliminate problems of anoxic water mass. These processes enable to restore an ecosystem in the water areas. This figure below show a summary of the processes presented to the international conference held in Netherlands in 1997.

New Process for Improvement of Contaminated Sediments by Succession of Micro-Biota



* Used for the 2nd ICCS September 7-11, 1997 at Rotterdam, Netherlands

Dear All Visitors:

In 1976, when Rural Environment Research Association began its activities as an environment think-tank organisation, it was generally accepted that microorganism was unable to remove nitrogen that causes eutrophication. In 1980, when I managed a basic document investigation concerning biochemistry, I was very much surprised at the 23rd figure on "The Microbe's Contribution to Biology" (A. J. Kluyver & C.B. Van Niel. Harvard University Press, Cambridge, Massachusetts, 1956). This figure shows "hidden enzyme reaction" that when oxygen in growth environment becomes insufficient, microorganism changes its metabolic function, reduces nitrate in medium culture, and releases reduced nitrate into air as molecular nitrogen gas. If I use this unique reaction of microorganism for wastewater treatment technologies, nitrogen in wastewater can release into air and, therefore, wastewater can be cleaned up. I, however, spent 20 years to find a way to resolve the issue.

As time advances, an ecosystem of microorganism autonomously organises its own microorganism that is suitable for growth environment. How to supply the most suitable amount of oxygen for oxygen demand of microorganism that is always changing? Prior technologies for wastewater treatment do not have any function to resolve it. New water facilities were required to supply oxygen flexibly and to suspend microorganism keep to equalise with lower aeration power.

To resolve this issue, Hybrid Lagoon ("HLS") has been developed and been in practical use through many environmental pollution areas from Hokkaido to Okinawa.

Including Europe, problems of water environment in the world have been becoming more serious. To resolve the problems, new technologies to satisfy both of higher quality of wastewater treatment and lower social burden are required. In this exhibition, we would like to introduce HLS that we have developed and already been in practical use and we hope that HLS will become one of wastewater treatment systems in Europe.

Rural Environment Research Association
Hiroshi Kishi, President

Rural Environment Research Association
702-10-9-1 Yushima Bunkyo-ku Tokyo, Japan
http://www.rera.org
webmaster@rera.org