PRR ©
(Progressive Reaeration & Recirculation)

Process Description

The PRR process utilizes Sunflo^2 Low-energy equipment to create the optimum kinetics (mixing) in combination with existing or purposed equipment to accelerate biological activity in a wastewater treatment pond.

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A THEORETICAL APPROACH: PROGRESSIVE REAERATION AND RECIRCULATION

The "white paper" identified at the end of this summary were developed by Warren Enyart, under the direction of Wayne Ruzicka, in an attempt to describe, quantify, and formulate the various observed phenomenon believed to be attributable to the Sunflo² technology. The research was primarily based upon literature reviews of relevant principles researched by other renowned scientists that are known to be influenced by the Sunflo² technology and believed to be probable causes for observed pond-based wastewater and freshwater treatment. The object of the paper is to provide a rational background for developing a few "short cut" formulae that will enable engineers and/or trained wastewater treatment personnel to predict the BOD removal rate that one could expect from the application of the Sunflo² units in a given pond environment.

The observed variables have been discussed in order of their theoretical importance to the outcome; measured in "BOD removal rate" (RR%). Ideally, the ultimate formula should be of the following order: RR% = f1 x f2 x f3x fn…, where, f1, f2, f3, etc are the variables discussed in the paper; the first of which has the most significant influence on the outcome, the next variable having less impact, and so on. Of course, at best this is only a theoretical framework to attempt to give relative weight to the variables as each might affect to treatment process, when the Sunflo² technology is properly applied.

The observed target is dictated by frequently observed performance of Sunflo² technology operating in typical wastewater ponds. In many such cases, the measured RR% after the application of the Sunflo² technology, was found to be five times that achieved by the unassisted facultative pond. Most of these ponds, while now overloaded, were originally designed under the USEPA standards for areal loading in a given climate. This is a strategic targeted metric, as many of the 8,000 pond-based treatment facilities in the United States were originally designed under the EPA criteria. In any case, the primary metric for any treatment process, is the reduction of BOD. And because the Sunflo² unit's operating principles depend a great deal on the surface area, in addition to the mixed portion of the pond (hence, "PRR"), these two parameters should be inherent in the ultimate formula to be derived.

A mathematician might review the tested formulae included in the paper and draft an empirical relationship among them that incorporates the observed phenomena attributable to the Sunflo² units. The empirical formula could serve as the hypothesis for controlled experimentation; with the ultimate goal to deduce a reliable, but simplified, design formula that will predict the RR% of the Sunflo² unit's application in a given pond. Although it is an oversimplification, if our theory is correct, the empirical formula for RR% should be equal to five times the basic formal used to predict the performance of an unassisted facultative pond designed in accordance with EPA guidelines.

RESEARCH SOURCES

In addition to the sources listed behind each "white paper", material was also sourced from some of the documents shown below.

1. 2nd International Symposium for Waste Treatment Lagoons. / [Edited and distributed by Ross E. McKinney.
   https://trove.nla.gov.au/work/21880804?q&versionId=26349749

2. Design manual: Municipal wastewater stabilization ponds E. J Middlebrooks, 1983
   https://scholar.google.com/scholar?q=Design+Manual,+Municipal+wastewater+

3. Environmental Systems Engineering, Linvil G. Rich
   https://books.google.com/books/about/Environmental_Systems_Engineering

4. Waste stabilization lagoons: a review of research and experience in design, construction, operation and maintenance: proceedings of a symposium at Kansas City, Mo., Aug. 1-5, 1960
   https://search.library.wisc.edu/catalog/999617268502121

5. Operations Manual, Stabilization Ponds, Chuck Zickefoose
   https://nepis.epa.gov/Exe/ZyNET.exe/9100

6. Sewage Stabilization Ponds in the Dakotas, W. Van Heuvelen, ND Department of Health
   https://nepis.epa.gov/Exe/ZyNET.exe/2000QW93.TXT?

7. Industrial Waste Treatment Practice, E.F. Eldridge

8. Sewage Treatment, Karl Imhoff and Gordon Fair
   https://www.amazon.com/Sewage-Treatment-Karl-Imhoff

9. Nitrogen Removal in Wastewater Stabilization Lagoons, Joe Middlebrooks
   http://www.bvsde.paho.org/bvsacd/leeds/removal.pdf

The following White Papers describes, quantifies, and formulates the various observed phenomenon believed to be attributable to the Sunflo² technology.

1. OXYGEN TRANSFER VIA REAERATION AND RECIRCULATION

2. OXYGEN UPTAKE CALCULATIONS

3. CALCULATION OF BOD5 REMOVAL: FIRST-ORDER REACTION RATE

4. EVAPORATION EFFECTS IN PONDS

5. NITROGEN REMOVAL via PRR

6. SLUDGE DEPOSITION AND DIGESTION

7. ALGAE CONTROL IN WASTEWATER AND FRESH WATER PONDS

DISCLAIMER

THE DOCUMENTS REFERENCED ABOVE WERE FIRST CREATED UNDER WAYNE RUZICKA'S DIRECTION BY AN EMPLOYEE (WARREN ENYART) AT WAYNE'S COMPANY PONDS RX US / POND DOCTOR INC. WARREN HAS A MASTER'S DEGREE IN PHYSICS AND IS A TRAINED RESEARCHER & TECHNICAL WRITER. THE DOCUMENT WAS WRITTEN IN 2004 BUT FOR ECONOMIC REASONS, ITS EXISTENCE WAS NOT USED COMMERCIALLY.

LiquidTEK LLC now owns the body of work and is updating it and applying test data from the Sunflo² products to the various formulas and claims. To date, the documents have only been partially updated, and have not been internally or peer reviewed so errors of computation may exist. However, it is fair to claim that the overall content and historical basis is factual, accurate and is well referenced.