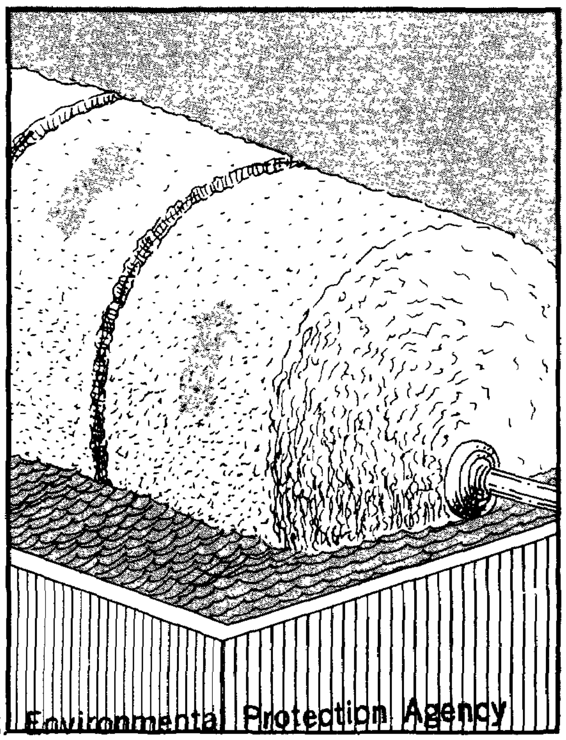
United States
Environmental Protection
Agency
Washington DC 20460

Revised
May
1984

# Rotating Biological Contactors (RBCs)



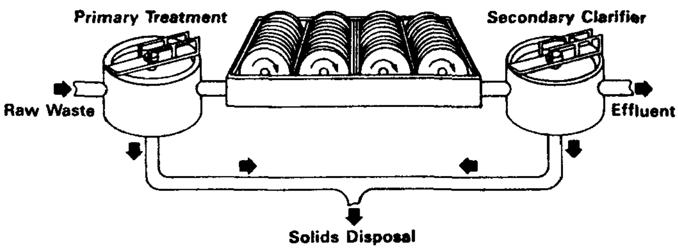
## Checklist for A Trouble-Free Facility



# Rotating Biological Contactors (I

## Introduction

Rotating biological contactors (RBC's) are relatively new to secondary wastewater treatment in the United States. RBC technology consists of plastic media, generally a series of vertical discs, mounted on a horizontal shaft that slowly rotates, turning the media into and out of a tank of wastewater. RBC shafts are generally 25-27 feet in length with a media diameter of 12 feet. About 40 percent of the media is submerged in the wastewater at any one time. Media are available in several different configurations for standard density media (100,000 sq. ft. of surface area per shaft) and high density media (150,000 sq. ft. of surface area per shaft). Microorganisms on the media oxidize organic wastewater constituents, reducing these pollutants to more benign components (biomass and gaseous by-products).




## Benefits

The advantages of RBC technology include a longer retention time (8 to 10 times longer than trickling filters), a higher level of treatment than conventional high-rate trickling filters, and less susceptibility to upset from changes in hydraulic or organic loading than conventional activated sludge.

Whether used in a small facility or a large municipal sewage treatment plant, the RBC process can efficiently remove 85% or more of the biochemical oxygen demand (BOD) from domestic sewage. The process can also be designed to remove ammonia nitrogen (NH3-N). In addition, effluents and process wastewater from dairies, bakeries, food processors, pulp and paper mills, and other biodegradable industrial discharges can be treated by the RBC process.

## History

During early pilot-scale operations, RBC's clearly offered the potential of improved secondary wastewater treatment. However, the construction and operation of full scale systems revealed major difficulties. Equipment failure contributed to some problems; design, construction, and operational flaws led to others.

EPA initiated extensive study into the causes of these problems. The breakdown of media, shafts, and bearings was investigated as well as low dissolved oxygen concentrations, nuisance bacterial growths, solids accumulations in undesirable locations, and periodic hydraulic overloads.

RBC equipment manufacturers initiated their own research and have modified their equipment and design criteria. For example, more durable shafts, bearings, and drive systems, and more conservative organic loading design criteria are now available to insure more efficient RBC wastewater treatment.

*In all RBC systems, major factors controlling* operation and performance are:

- Organic and Hydraulic Loading Rates
- Influent Wastewater Characteristics
- Wastewater Temperature
- Biofilm Control
- Dissolved Oxygen Levels
- Operational Flexibility

## Why a Checklist?

The EPA research indicates that when properly designed, built, and operated, RBC's can provide an acceptable alternative to conventional activated sludge systems. By heeding past experience, designers, contractors, and operators may avoid the difficulties encountered by some of the first full scale systems.

**Inside this folder is a checklist of RBC planning, design, and construction considerations based on the history of problems and the EPA research findings. Utilization of this checklist as future plants are planned and built will reduce the risk of unforeseen treatment problems.**

Other more detailed technical assistance will be necessary when actually determining design, construction, operation, and maintenance details.

# RBC Checklist: for Planning, Design, a

The following checklist is based on treatment facility designs t
All design parameters should be compared with applicable St

Organic loading to the first stage is a critical factor in the design of an RBC system. Indications from research and field observations are that loadings in the range of 6.0-8.0 lbs total $BOD_5$/1000 $ft^2$/day or 2.5-4.0 lbs soluble $BOD_5$/1000 $ft^2$/day can be acceptable. Loadings in the higher end of these ranges will increase the likelihood of developing problems such as heavier than normal biofilm thickness, depletion of dissolved oxygen, nuisance organisms, and deterioration of overall process performance. The structural capacity of the shaft, provisions for stripping biomass, consistently low influent levels of sulphur compounds to the RBC units, the media surface area required in the remaining stages, and the ability to vary the operational mode of the facility (see Nos. 5, 7, and 8) may justify choosing a loading in the high end of the range, but the operator must carefully monitor process operations (see No. 24).

Soluble BOD loading is a critical parameter in the design of RBC units and should be verified by influent sampling whenever possible. Organic loading considerations during design must include contributions from in-plant sidestreams, septage dumps, etc.

High influent hydrogen sulfide ($H_2S$) concentrations can impede RBC performance because of the acceleration of nuisance growths. When higher than normal influent or sidestream $H_2S$ concentrations are anticipated, appropriate modifications in the design should be considered.

Except under special circumstances, high density media should not be used in the first stage. Use of high density media in subsequent stages should be based on appropriate load criteria, structural limitations of the shaft and media, and media configuration.

If organic loading rates are maintained within the ranges discussed in No. 1, the biofilm growth would not be expected to exceed 0.10 inches. However, over the life of a facility, organic loadings will vary considerably and biofilm growths of 0.18 inches have been observed. Therefore, the engineer should specify a load bearing capacity for each shaft that considers the maximum anticipated biofilm growth, the capacity to strip excess biofilm (see No. 7), and an adequate margin of safety.

The engineer should require the manufacturer to provide adequate assurance that the shaft and media support structures are protected from

at incorporate rotating biological contactors as the principal secon
e design criteria to assure compliance with State agency requirem

structural failure for the design life of the facility. Structural designs should be based on appropriate American Welding Society (AWS) stress category curves modified as necessary to account for the expected corrosive environment. All fabrication during construction should conform to AWS welding and quality control standards.

A means for removing excess biofilm growth should be provided, such as air or water stripping, chemical additives, rotational speed control/reversal, etc.

Adequate flexibility in process operation should be provided by considering one or more of the following:

- Variable rotational speeds in first and second stages.
- Multiple treatment trains.
- Removable baffles between all stages.
- Positive influent flow control to each unit or flow train.
- Positively controlled alternate flow distribution systems, such as step feed.
- Positive air flow metering and control to each shaft when supplemental aeration or air drive units are used.
- Recirculation of secondary clarifier effluent.

Effective treatment, through the use of primary clarifiers or fine screens, must be provided ahead of the RBC units.

Periodic high organic loadings may require supplemental aeration in the first stage.

When peak to average flow ratio is 2.5 to 1.0 or less, average conditions can be used for design. For higher flow ratios, flow equalization should be considered.

Available data indicate that organic removal and nitrification rates diminish at wastewater temperatures below 55°F. Below 55°F, manufacturers utilize correction factors to determine needed additional media surface area.

Nitrification with RBC units is sensitive to flow and organic loading surges, requiring evaluation of flow equalization vs. additional RBC media surface when consistently low ammonia nitrogen levels are required in the effluent.

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Small-diameter RBC pilot units are suitable for determining the treatability of a wastewater. However, direct scale-up from such units to full scale is not possible because of the effects of temperature, peripheral speed of media, and other process and equipment factors.

Load cells should be provided for all first and second stage shafts. Load cells for all other shafts in an installation are desirable.

First stage dissolved oxygen (DO) monitoring should be provided. The RBC unit should be designed to maintain a positive DO level in all stages.

Based on field measurements on 105 shafts at 22 installations in 1983, it was determined that actual energy requirements for mechanically driven RBC units ranged from 1.05 kW/shaft to 3.76 kW/shaft (average 2.03). Of the shafts measured, 62% had 5 hp motors and the remainder has 7.5 hp motors. The units measured included both standard and high density media, and the biofilm growths varied from very light to medium. Current industry practice generally uses 5 hp motors, and manufacturer's estimates of energy requirements fall within the range identified above, with an average close to the field measured units. In evaluating actual energy requirements, the engineer should consider the influences of drive train efficiency, temperature, biofilm thickness, media surface area, and rotational speed.

With air drive units, the energy requirements (kW/shaft) can not be measured directly. However, for comparative purposes an approximation can be made by dividing the blower kW by the number of driven shafts. Field measured energy requirements for air driven RBC units at 7 installations during 1983 ranged from 3.8 kW/shaft to 8.3 kW/shaft (average 5.2). Actual energy requirements will depend on desired rotational speed, air flow, piping configurations, and blower efficiency.

Energy estimates used for planning and design should be based on expected operating conditions such as temperature, biofilm thickness, rotational speed, and media surface area instead of normalized energy data sometimes supplied by equipment manufacturers. Care should be taken to assure that manufacturer's data are current and reflect actual field-validated energy usage.