



PRODUCT BROCHURE

# Rotating Disk Reactor

## RDR-350

*High-pressure, high-temperature study of reaction kinetics and mass transfer between a fluid and a solid surface.*



RDR-350 | Floxlab geotechnical & laboratory testing equipment

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01 • OVERVIEW

# How the rotating disk reactor works

*Reaction kinetics & mass transfer under HP / HT conditions*

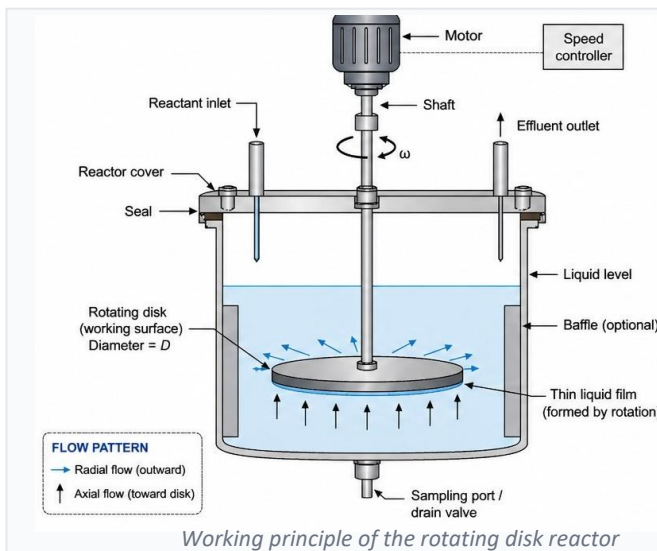
The RDR-350 investigates reaction kinetics and mass transfer between a fluid (acid solution) and a solid surface (carbonate disk) under high-pressure and high-temperature conditions. Carbonate disks are placed inside a reaction vessel and rotated while the mineral dissolution rate in the acid is monitored.

**KEY CAPABILITIES**

- Acid-rock reactions
- Controllable mass-transfer rate
- Up to 5,000 psi & 250 °C
- Hastelloy wetted parts
- Semi-automated apparatus

**WORKING PRINCIPLE**

## Operating sequence



*Working principle of the rotating disk reactor*



*Carbonate disks ready for the RDR test*

- 1 The motor rotates the disk at a controlled angular speed ( $\omega$ , rpm).
- 2 Liquid is fed into the reactor through the reactant inlet.
- 3 Centrifugal force spreads the liquid across the disk into a thin film.
- 4 Fluid flows radially outward along the disk surface.
- 5 Bulk fluid moves axially toward the disk, renewing the film.
- 6 Reaction occurs at the solid-liquid interface on the disk.
- 7 Reacted fluid leaves the reactor through the effluent outlet.

## 02 • PURPOSE

# What the apparatus is designed for

*Critical parameters for modeling acidizing processes in petroleum reservoirs*

*The RDR-350 is designed to study reactions between fluid and solid surface under high-pressure, high-temperature operating conditions. It is used to determine:*

1

**Mineral dissolution rate**

Dissolution rate of minerals contained in carbonate rock in acid (calcite or dolomite).

2

**Mass-transfer coefficient**

Determination of the mass-transfer coefficient  $k_m$  between the bulk fluid and the disk surface.

3

**Mass flux rate**

Mass flux rate  $J$  — diffusion coefficient describing transport of reactant to the surface.

4

**Reaction rate**

Reaction rate  $r$  representing the surface kinetics between acid and rock.

5

**Operating-condition effects**

Effects of temperature, rotation speed, and fluid properties on overall reaction behaviour.

## 03 • KINETICS &amp; MASS TRANSFER

# What controls the dissolution rate

The phenomena governing the rotating disk reactor

**OVERALL REACTION RATE**
**01**

$$r = J \cdot A = k_m \cdot A \cdot (C_b - C_s)$$

$r$  represents how fast the rock dissolves or reacts with the acid. The reaction rate increases with higher mass transfer  $k_m$ , larger surface area  $A$  and a larger concentration gradient.

**MASS FLUX TO THE DISK SURFACE**
**02**

$$J = k_m \cdot (C_b - C_s)$$

$J$  is the number of reactant molecules arriving at the disk surface per unit time.  $C_b$  is the bulk concentration,  $C_s$  the surface concentration. A greater concentration difference means more molecules reach the surface.

**MASS-TRANSFER COEFFICIENT**
**03**

$$k_m = 0.62 \cdot D^{2/3} \cdot \nu^{-1/6} \cdot \omega^{1/2}$$

Levich equation.  $k_m$  describes how easily molecules move from the liquid to the rock surface. Rotation improves the mass-transfer rate, scaling with the square root of rotation speed  $\omega$  ( $k_m \propto \omega^{1/2}$ ).

**ACID DISSOLUTION OF CARBONATE**
**04**

$$Ca^{2+} / Mg^{2+} \rightarrow \textit{measured vs. time}$$

The dissolution rate is measured by analysing dissolved  $Ca^{2+}$  or  $Mg^{2+}$  ions in the fluid over time using atomic spectroscopy. Concentration evolution gives the reaction rate directly.

## 04 • MAIN COMPONENTS

# Subsystems delivered with the RDR-350

*An integrated, ready-to-use HP / HT testing system*

## 01

### Reaction Vessel

Hastelloy HP/HT vessel where the acid–rock reaction occurs. Holds the rotating spindle, embedded heating cartridges, cooling jacket, gas and acid inlets, sample outlet, burst disc, pressure transducer and temperature probe.

## 02

### Transfer Vessel

Hastelloy HP/HT reservoir storing the test fluid before injection. Embedded heating and cooling jacket maintain isothermal conditions. Connected to the reaction vessel via the N<sub>2</sub> pressurisation circuit.

## 03

### Chiller

Provides cold water to the reaction and transfer vessels for rapid heat transfer. Temperature range –15 to 40 °C with stability ±0.2 °C. 230 VAC / 50 Hz.

## 04

### Fraction Collector

Model 2110, 80 polypropylene tubes; time- or drop-based collection. Programmable from front panel or remotely. 24 × 33 × 25 cm footprint.

## 05

### N<sub>2</sub> Gas Booster

Compresses and transfers low-pressure N<sub>2</sub> up to 5,000 psi into the HP vessels. Manual valves, air regulator, filter, high-pressure tubing and fittings.

## 06

### Data Acquisition

PC workstation with Floxlab supervision software controlling test duration, rotation speed, temperature, pressure and automatic sampling at user-defined intervals.

## 05 • SPECIFICATIONS

# Technical data & typical applications

*Performance envelope and where the RDR-350 is used*

KEY FEATURES & BENEFITS	
Maximum pressure	5,000 psi
Maximum temperature	Ambient → 250 °C
Reaction vessel volume	500 cc
Transfer vessel volume	500 cc
Sample disk diameter	1.5 in (3.81 cm)
Sample disk thickness	1 in (2.54 cm)
Disk rotational speed	100 – 2,000 rpm
Wetted-part material	Hastelloy
Required N <sub>2</sub> pressure	2,000 psi
Required air pressure	150 psi, dry
Power supply	110 – 220 VAC, 50/60 Hz
Internal vessel diameter	75 mm

## TYPICAL APPLICATIONS

### Petroleum Engineering

Acid–rock reactions for well-stimulation and carbonate dissolution studies.

### Reaction Kinetics

Rate constants and reaction-rate measurements for fluid–solid systems.

### Mass-Transfer Studies

Mass-transfer coefficient and boundary-layer quantification.

### Corrosion & Dissolution

Corrosion of metals; dissolution of rocks and minerals.

### Scale & Precipitation

Precipitation, scale formation and inhibitor effectiveness.

### Electrochemistry & Biofilms

Electrodeposition; biomass and biofilm growth on surfaces.

***Rapid, accurate and reproducible data — small test-fluid volume, semi-automated apparatus.***

## TEST PROCEDURE

- Mount 1.5 in carbonate disk on rotating spindle
- Seal reaction vessel; heat to test temperature
- Load test fluid into transfer vessel; preheat
- Pressurise system with N<sub>2</sub> to working pressure
- Push fluid into reaction vessel using N<sub>2</sub>
- Start disk rotation at preset speed
- Collect fluid samples at preset intervals
- Measure Ca<sup>2+</sup> / Mg<sup>2+</sup> by atomic absorption
- Plot reaction rate vs  $\omega$  → identify regime
- Repeat at varying  $\omega$ , T, concentration → rate law

## GET IN TOUCH

# Let's talk about your project

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## Thank you

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