

# OXIDATION STABILITY – RPVOT & TFOUT

**Oxidation Stability of Steam Turbine Oils by Rotating Pressure Vessel (Bomb)**  
**Oxidation Stability of Inhibited Mineral Insulating Oil by Rotating Pressure Vessel (Bomb)**  
**Oxidation Stability of Gasoline Automotive Engine Oils by Thin Film Oxidation Uptake (TFOUT)**

## Test Method

The RPVOT (RBOT) procedure employs severe oxidation conditions to rapidly determine oxidation stability. Suitable for both new and in-service oils, the RPVOT (RBOT) method is applicable to many types of petroleum oils. The sample is oxidized in the presence of water and a copper catalyst in a stainless steel pressure vessel under an initial pressure of 90psi (620kPa). Pressure inside the vessel is recorded electronically or mechanically while the vessel is rotated at 100rpm at constant temperature, and the amount of time required for a specified drop in pressure is the oxidation stability of the sample. A variation of the RPVOT (RBOT) method is the “Thin Film Oxidation Uptake Test” (TFOUT) for gasoline automotive engine oils.

## RPVOT (RBOT) Test Apparatus

- 2, 3 and 4-unit systems
- Oxidata® Pressure Measurement System
- Conforms to ASTM D2112, D2272 and IP 229 specifications for RPVOT (RBOT) testing
- Conforms to ASTM D4742 specifications for TFOUT testing

For product specifications and ordering information:

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## Oxidation Pressure Vessel

- Polished stainless steel construction
- Can be converted for use in the Thin Film Oxidation Uptake Test (TFOUT)

Consists of pressure vessel body, cap and stem with inlet needle valve in accordance with ASTM specifications. Vessel holds one borosilicate glass sample container between two PTFE discs. Closure ring tightens by hand to seal cap to pressure vessel body. Vessel connects to pressure recorder or rotary transducer and rotates on magnetic carriage in RBOT bath. Withstands working pressure of 500psi (3450kPa) per ASTM specifications. Stainless steel construction ensures proper rate of heat transfer. Closure ring is constructed of chrome plated steel. Includes PTFE fluorocarbon wear disc and sample container cover disc.



*Oxidata® Pressure Measurement System*

## Oxidata® Pressure Measurement Systems

- Electronic pressure measurement systems exclusively designed for RPVOT (RBOT), TFOUT and other ASTM oxidation test methods
- Powerful Oxidata® software for Windows® and Windows 95® environments
- Monitors up to twelve pressure and four temperature channels
- **Can be installed to most manufacturer's RPVOT(RBOT)/TFOUT test apparatus**

Complete electronic measurement systems for plotting pressure versus time and temperature in RPVOT (RBOT) and TFOUT testing. Each system includes transducers, bomb couplings, RTD probe assembly, multiplexer, data acquisition card, software, and mounting and connecting hardware. Systems are available in two, three and four pressure vessel configurations, and additional channels can be added for up to a total of twelve pressure and four temperature channels.

Koehler pressure measurement systems for RPVOT (RBOT) and TFOUT feature Oxidata®, a high accuracy pressure measurement software package designed exclusively for ASTM oxidation test methods. Designed to run in a Windows® or Windows 95® environment, Oxidata® monitors up to twelve samples simultaneously, with graphical or tabular display of results. Each channel can be independently configured for any of the applicable ASTM standard test methods without compromising the independence or accuracy of the other channels. Independent start and stop times and user programmable end points add even greater flexibility.

The software plots your data on screen on line, real time, and automatically saves your data on disk or to the hard drive during the test to prevent loss of valuable data. Multiple display options include the ability to view the status of all twelve pressure channels on screen simultaneously and then click on any one channel for a graph display; or to view four channels in graphical format simultaneously. Powerful program features allow you to change axes, have colored plot lines and zoom in on a specific plot sector to view data in greater detail.

### Ordering Information

<b>Catalog No.</b>	
<b>K70000</b>	Oxidation Pressure Vessel
<b>K70092</b>	Aluminum Insert
	Converts standard K70000 Oxidation Pressure Vessel for use in the TFOUT method

# OXIDATION STABILITY – RPVOT & TFOUT

## Oxidata® Features and Specifications

- On-line, real time monitoring of up to twelve samples simultaneously - results plot directly to the screen for instant monitoring or printout of results
- Menu options for RPVOT (RBOT) or TFOUT testing, as well as for other ASTM fuel and lubricant oxidation tests
- Programmable automatic end point detection with graphical and tabular representation
- Each channel can be configured and operated independently with different start/stop times and different ASTM test methods
- Zoom in feature allows for magnification of any plot sector on any channel for a more detailed study
- Monitors and reports temperatures of as many as four baths simultaneously using accessory RTD's, and calculates and displays average temperature for each bath. Exports data to spreadsheet programs such as Microsoft Excel®, Lotus 1-2-3®, etc.
- Temperature and pressure calibration capability
- Data is saved directly to the hard drive during testing to prevent loss of valuable data
- Operates in Windows® 2000 or higher
- Simple upgrade from existing Koehler data acquisition systems

## Included Accessories (for the pressure measurement systems)

Rotary transducers (connects directly to bomb)

Data acquisition box with USB interface

Oxidata® software

Multiplexer

RTD probe assembly (1)

Mounting Bracket for bath

Connecting cables and hardware

## Computer Requirements

Processor: Intel® Pentium II or similar (minimum)

Memory (RAM): 256MB or higher

Speed: 500 MHz or higher

Windows® 2000 or higher

Disk Space: 15 MB free space (minimum)

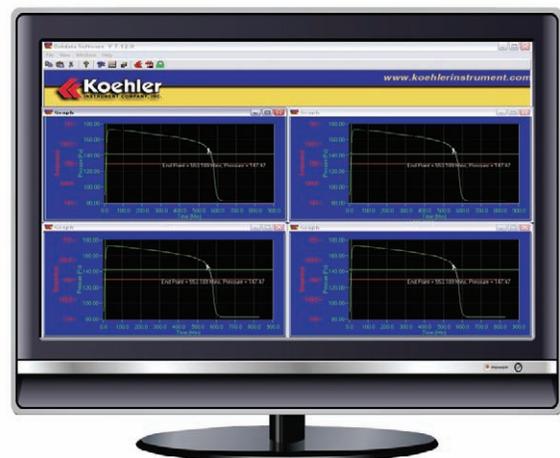
Communications Port: One USB port

Other Software: Microsoft® Excel (97 or above)

One RS232 port for temperature controller (optional)



Oxidata® Software automatically calculates and displays the endpoint of RPVOT (RBOT)/TFOUT test methods.



Real-time plot screen displays pressure versus time for up to twelve samples simultaneously.

## Ordering Information

The ordering information below is for installation to Koehler equipment. For other makes of equipment, a few basic hardware items may also be required - please contact your Koehler representative for assistance.

### Catalog No.

### RBOT/TFOUT Electronic Pressure Measurement System € €

- K70502-XP** Two-Unit System, 115V 60Hz
- K70592-XP** Two-Unit System, 220-240V 50/60Hz
- K70503-XP** Three-Unit System, 115V 60Hz
- K70593-XP** Three-Unit System, 220-240V 50/60Hz
- K70504-XP** Four-Unit System, 115V 60Hz
- K70594-XP** Four-Unit System, 220-240V 50/60Hz

## Oxidata® Retrofit Kits

To upgrade your existing Koehler electronic pressure measurement system to the Oxidata® software, please refer to page 118.

# OXIDATION STABILITY – RPVOT & TFOUT

## Oxidation Baths

- Two, three and four-pressure vessel models
- Conforming to ASTM requirements for RPVOT (RBOT) and TFOUT testing

Constant temperature bath rotates oxidation pressure vessels at 100rpm at an angle of 30° in accordance with ASTM specifications. Includes drive system and oil bath with electronic solid state temperature control. Meets ASTM requirements for heat transfer capability and temperature control precision.

A convenient carriage arrangement allows the oxidation vessels to be inserted quickly and securely in the drive system. A strong magnet holds the vessel in place while locating pins in the carriage engage the base of the vessel. PTFE guides support the pressure vessel stem for added stability. If the vessel becomes obstructed for any reason, the magnetic carriage releases it to prevent damage. A chain and sprocket drive system powered by a heavy duty capacitor start motor rotates the vessel carriages at 100rpm. Drive shafts ride on PTFE fluorocarbon bearings which provide extended service and are compatible with silicone heat transfer fluids and other types of bath oils.

Bath temperature is controlled within ASTM specified limits by an electronic solid state controller with °C/°F switchable digital setpoint and display. Overtemperature protection is provided by a built-in limit control that automatically interrupts power to the bath when bath liquid temperature exceeds 16.7°C (30°F) above the temperature setting or 177°C (350°F). Power must then be manually restored by the operator after checking the cause of the problem. Pressure vessel carriage vanes circulate the bath oil during testing to ensure temperature uniformity, and an auxiliary stirrer can be operated between tests to prevent sludging of non-silicone bath oils.

The bath interior is constructed of welded stainless steel and is fully insulated. A hinged section of the bath cover provides easy access to the vessel carriages. Vapor barriers in the cover close around the vessel stems to contain vapors from the hot bath medium. A chemical resistant polyurethane finish protects the bath exterior and control cabinet.



## Specifications

Conforms to the specifications of: ASTM D2112, D2272, D4742; IP 229  
Capacity: 2, 3 or 4 oxidation pressure vessels

Temperature Control:

Maximum Temperature: 200°C (392°F)

Control Stability: ±0.02°C (±0.04°F)

Heater Range:

2 and 3-pressure vessel models: 0-2750W

4-pressure vessel models: 0-3750W

Recommended Bath Medium: high temperature silicone heat transfer fluid (355-001-002 or 355-001-004—page 8)

Drive System: 100rpm positive drive transmission powered by a continuous duty ½hp ball bearing motor with built-in gear reducer

Ordering Information						
Catalog No	Capacity	Electrical Requirements C €	Bath Capacity, gal (L)	Dimensions, lwxh, in. (cm)	Net Weight	Shipping Weight
K70200	2 oxidation vessels	220-240V 60Hz, 17.17A	18 (68)	28x26x33	237 lbs (107.5kg)	356 lbs (161.5kg) 25.3 Cu. ft.
K70290		220-240V 50Hz, 17.17A		(71x66x84)		
K70300	3 oxidation vessels	220-240V 60Hz, 17.17A	25 (95)	37x26x33	284 lbs (129kg)	416 lbs (188.7kg) 32 Cu. ft.
K70390		220-240V 50Hz, 17.17A		(94x66x84)		
K70400	4 oxidation vessels	220-240V 60Hz, 21.5A	32 (121)	46x26x33	375 lbs (170kg)	542 lbs (245.9kg) 40.3 Cu. ft.
K70490		220-240V 50Hz, 21.5A		(117x66x84)		

- For verifying bath temperature in accordance with ASTM and IP test method specifications

Ordering Information	
<b>Catalog No.</b>	
250-001-37C	IP 37C Thermometer. Range: 144 to 156°C For RPVOT (RBOT) method.
250-000-96C	ASTM 96C Thermometer. Range: 120 to 150°C For ASTM D2112 method.
250-000-100C	ASTM 100C Thermometer. Range: 145 to 205°C For TFOUT method.

For NIST traceable certified thermometers, please refer to the ASTM Thermometers sections on pages 184 through 191.

# OXIDATION STABILITY – RPVOT & TFOUT

## Oxidation Pressure Vessel Accessories

- Sample beakers for RBOT and TFOUT methods
- Oxygen charging accessories

Ordering Information	
<b>Catalog No.</b>	
<b>Sample Beakers</b>	
<b>K70040</b>	RPVOT (RBOT) Sample Beaker Borosilicate glass, 175mL Meets ASTM D2112, D2272 specifications
<b>K70091</b>	TFOUT Sample Container Borosilicate glass. Meets ASTM D4742 specifications
<b>Oxygen Charging Accessories</b>	
<b>K70080</b>	Charging Hose. 6 ft (1.8m), with connections
<b>K70082</b>	Female Quick Disconnect Coupling, for charging hose
<b>K70081-1</b>	Male Quick Disconnect Coupling, ¼" NPT, for oxidation pressure vessel
<b>K70013</b>	Oxygen Pressure Regulator
<b>Oxidation Pressure Vessel Accessories</b>	
<b>K70050</b>	Silicone O-ring Replacement seal for pressure vessel lid-body connection
<b>K70049</b>	Sample Beaker Cover (PTFE disk)
<b>K70048</b>	TFOUT Sample Beaker Cover (PTFE disk)
<b>K70000-03008</b>	Spring. Inserts in pressure vessel to hold RPVOT (RBOT) beaker and cover in place
<b>K700-0-3A</b>	Spring. Inserts in pressure vessel to hold TFOUT container and cover in place

## Pressure Recorder

- Conforms to ASTM D2112, D2272, D4742 and IP 229 specifications  
Records pressure inside oxidation bomb on 24-hour charts. Range 0 to 200psi, accurate to within 2% of scale range, 24-hour spring wound chart movement. Housed in a finished metal case. Includes cartridge pen.

Ordering Information	
<b>Catalog No.</b>	
<b>K70010/24</b>	Pressure Recorder, 24-hour
<b>Accessories</b>	
<b>K70018</b>	Replacement Cartridge Pen
<b>308-000-004</b>	Recorder Chart, 24-hour Box of 60 charts

*Oxidata® pressure measurement equipment is now available for the RPVOT (RBOT) and TFOUT Methods. Please refer to page 115.*

## Pressure Vessel Support Racks

- For convenient handling of oxidation pressure vessel during assembly and disassembly

Securely holds vessel-recorder assembly in an upright position. Convenient for assembling and disassembling vessel. Equipped with drainage trough for bath oil remaining on the vessel exterior after testing.

Ordering Information	
<b>Catalog No.</b>	
<b>K70017</b>	Pressure Vessel Support Rack, 2-Unit
<b>K70011</b>	Pressure Vessel Support Rack, 3-Unit
<b>K70012</b>	Pressure Vessel Support Rack, 4-Unit

## Catalysts

- For Rotating Pressure Vessel Oxidation Test (RPVOT)
- For Thin Film Oxidation Uptake Test (TFOUT)

Ordering Information	
<b>Catalog No.</b>	
<b>Copper Catalyst for RPVOT (RBOT) Method</b>	
<b>K70030</b>	Copper Catalyst Coil Prepared in accordance with ASTM specifications and packed in a sealed glass container with nitrogen atmosphere. Ready to use.
<b>K70090</b>	Copper Catalyst Wire 1.63mm electrolytic copper wire in 500 ft (152m) lengths.
<b>K70002</b>	Winding Mandrel Machined aluminum mandrel for winding copper wire into coils meeting ASTM specifications. Mounts on K70003/K70004 Drive Unit
<b>K70003</b>	Drive Unit for Winding Mandrel Slow speed gear motor mounted on a sturdy base. Facilitates coil winding procedure. 115V
<b>K70004</b>	Drive Unit for Winding Mandrel Similar to K70003 but for operation on 220-240V
<b>Catalyst Package for TFOUT Method</b>	
<b>K70093</b>	Catalyst Package A For simulating IIID engine test. Includes 3 catalyst packages
<b>K70095</b>	Catalyst Package B For simulating IIIE engine test. Includes 3 catalyst packages

## OXIDATION – RPVOT & TFOUT

### 2 Unit RBOT System:

K70200	Oxidation Bath (or K70290)	
K70000	Oxidation Pressure Vessel (2)	
K70502-XP	Oxidata® Pressure Measurement System (or K70592-XP)	
K70002	Winding Mandrel	
K70003	Drive Unit (or K70004)	
K70017	Pressure Vessel Support Rack	
250-001-37C	IP 37C Bath Thermometer	
K70080	Charging Hose	
K70082	Female Quick Disconnect Coupling for charging hose	
K70081-1	Male Quick Disconnect Coupling for oxidation pressure vessel (2)	
K70013	Oxygen Pressure Regulator	} Order sufficient quantity to meet anticipated testing requirements.
K70030	Copper Catalyst Coils	
K70090	Copper Catalyst Wire, 500 ft.	
K70040	Sample Container	
K70050	Silicone O-ring	

### 3-Unit RBOT System:

K70300	Oxidation Bath (or K70390)	
K70000	Oxidation Pressure Vessel (3)	
K70503-XP	Oxidata® Pressure Measurement System (or K70593-XP)	
K70002	Winding Mandrel	
K70003	Drive Unit (or K70004)	
K70011	Pressure Vessel Support Rack	
250-001-37C	IP 37C Thermometer	
K70080	Charging Hose	
K70082	Female Quick Disconnect Coupling for charging hose	
K70081-1	Male Quick Disconnect Coupling for oxidation pressure vessel (3)	
K70013	Oxygen Pressure Regulator	} Order sufficient quantity to meet anticipated testing requirements.
K70030	Copper Catalyst Coils	
K70090	Copper Catalyst Wire, 500 ft.	
K70040	Sample container	
K70050	Silicone O-ring	

### 4-Unit RBOT System:

K70400	Oxidation Bath (or K70490)	
K70000	Oxidation Pressure Vessel (4)	
K70504-XP	Oxidata® Pressure Measurement System (or K70594-XP)	
K70508	Mounting Bracket for Four-Unit XP System	
K70002	Winding Mandrel	
K70003	Drive Unit (or K70004)	
K70012	Pressure Vessel Support Rack	
250-001-37C	IP 37C Thermometer	
K70080	Charging Hose	
K70082	Female Quick Disconnect Coupling for charging hose	
K70081-1	Male Quick Disconnect Coupling for oxidation pressure vessel (4)	
K70013	Oxygen Pressure Regulator	} Order sufficient quantity to meet anticipated testing requirements.
K70030	Copper Catalyst Coil	
K70090	Copper Catalyst Wire, 500 ft.	
K70040	Sample Container	
K70050	Silicone O-ring	

### For TFOUT testing, make the following substitutions:

K70091	Sample Beaker (replaces K70040)	
K70092	Aluminum Insert (2, 3 or 4)	
K70095	TFOUT Catalyst Package (in lieu of K70030, K70090, K70002, K70003)	}

250-000-100C ASTM 100C Thermometer (replaces 250-001-37C)

### Oxidata® Retrofit Kits

To upgrade existing DOS-based Koehler electronic pressure measurement systems to the Oxidata® system. Kits include Oxidata® software, data acquisition card, multiplexer board, RTD probe assembly and connecting cables. Does not include rotary transducers or bath mounting bracket. For information on upgrading other makes of equipment to the Oxidata® system, please contact your Koehler representative.

#### Ordering Information

<b>Catalog No.</b>	
<b>K70502RETRO</b>	2-Unit Oxidata® Pressure Measurement System without Transducers, 115V 60Hz
<b>K70592RETRO</b>	2-Unit Oxidata® Pressure Measurement System without Transducers, 220-240V 50/60Hz
<b>K70503RETRO</b>	3-Unit Oxidata® Pressure Measurement System without Transducers, 115V 60Hz
<b>K70593RETRO</b>	3-Unit Oxidata® Pressure Measurement System without Transducers, 220-240V 50/60Hz
<b>K70504RETRO</b>	4-Unit Oxidata® Pressure Measurement System without Transducers, 115V 60Hz
<b>K70594RETRO</b>	4-Unit Oxidata® Pressure Measurement System without Transducers, 220-240 50/60Hz

#### Accessories

<b>K70500</b>	Rotary Transducer Includes electronic transducer and rotating stainless steel housing
<b>K70519</b>	RTD Kit, for monitoring the temperature of an additional bath

*For NIST traceable certified thermometers, please refer to the ASTM Thermometers sections on pages 184 through 191.*