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Technical Information

Rxn-45 Raman spectroscopic probe

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People for Process Automation

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Function and system design

Fields of application

The Rxn-45 Raman spectroscopic probe is designed for the needs of bioprocessing pilot and manufacturing sites.

Recommended applications include:

- **Cell culture:** Glucose, lactate, amino acids, cell density, titer, and more
- **Fermentation:** Glucose, glycerol, acetate, methanol, ethanol, biomass, and more

Use of the device for any purpose other than that described, poses a threat to the safety of people and of the entire measuring system and invalidates any warranty.

Laser safety interlock

The Rxn-45 probe, as installed, forms part of the interlock circuit. The interlock circuit is a low-current electrical loop. If the fiber cable is severed, the laser will turn off within 20 milliseconds of the breakage.

NOTICE

Handle probes and cables with care.

Fiber cables should NOT be kinked and should be routed to maintain the minimum bend radius of 6 inches (152.4 mm).

▶ Permanent damage may result if cables are not routed appropriately.

The Electro-Optical (EO) fiber cable with its embedded interlock loop must be plugged into the back of the Raman Rxn analyzer for the appropriate channel. The interlock loop is complete when the probe side of the EO fiber cable is plugged into the Rxn-45 probe.

When there is potential for the laser to be energized, the laser interlock indicator light on the probe body is illuminated.

Rxn-45 probe

The Rxn-45 probe with the right angle connection is shown below.

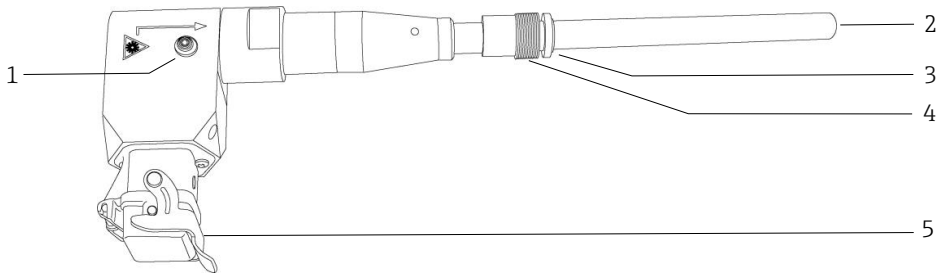

Figure 1: Rxn-45 probe

#	Name	Description
1	Laser interlock indicator light	Illuminated when there is potential for the laser to be energized
2	Probe tip	Tip of probe for sample interface; 120 mm immersion length
3	Flange and o-ring	Welded flange and replaceable USP Class VI o-ring to ensure a tight seal with the vessel port/hardware
4	Captive nut	PG13.5 thread for industry standard sensor housings; welded port connectors available
5	Fiber optic cable connector	Electro-Optical (EO) fiber connection under spring-loaded fiber connector cap

Table 1. Rxn-45 probe parts

Installation

During installation, standard eye and skin safety precautions for Class 3B laser products (as per EN-60825/IEC 60825-14) should be observed as described below.

⚠ WARNING	**Standard precautions for laser products should be observed.** ▶ Probes should always be capped and/or pointed away from people toward a diffuse target if not installed in a sample chamber.
⚠ CAUTION	**The laser input into the probe must not exceed 499 mW.** **If stray light is allowed to enter an unused probe, it will interfere with data collected from a used probe and may cause calibration failure or measurement errors.** ▶ Unused probes should ALWAYS be capped to prevent stray light from entering the probe.
NOTICE	**When installing the probe *in situ*, the user must provide the strain relief to the fiber optic cable at the probe installation location.**

Data collection zone: Short

All versions of the Rxn-45 probe utilize short data collection zones. The short data collection zone maximizes spectral reproducibility by minimizing the impact of sample opacity, sample color, and transient particulates on the measured Raman spectrum.

Specifications

General specifications

General specifications for the Rxn-45 probe are listed below. Additionally:

Note: Max service pressure ratings do not include the ratings of any fittings or flanges used to mount the probe into the process system. These items need to be independently evaluated and may lower the maximum service pressure of the probe.

Item		Description
Maximum laser power into probe		<499 mW
Relative humidity		Up to 95%, non-condensing
Maximum service pressure (at tip)		≤ 13.8 Bar (200 psi)
Laser wavelengths		785 nm and 993 nm
Process connection		PG13.5 thread for industry standard sensor housings; welded port connectors available
Rating		IP-65
Depth of field		0.33 mm (FWHM)
Chemical resistance		Limited by materials of construction
Sterilization protocol compatibility		SIP/CIP
Spectral coverage	785 nm	150 – 3425 cm^{-1}
	993 nm	200 – 2400 cm^{-1}
Temperature	Window, at tip	–30°C to +150°C
	Probe body	up to +150°C
	Temperature ramp	30°C/min
Probe measurements	Immersion length	120 mm
	Diameter	12 mm
	Dimensions	306 mm x 127 mm x 34 mm
Materials of construction Wetted, in contact with sample	Probe body	316L stainless steel
	Window	Proprietary material, optimized for bioprocesses
	Adhesive	USP Class VI and ISO993 compatible
	Surface finish	Ra 15 with Electropolish to ASME BPE SF4 finish
	Fiber optic cable	• Design: PVC jacketed, proprietary construction • Connections: proprietary electro-optic (EO) or FC to EO fiber converter(s) for non-embedded systems
Fiber optic cable specifications	Length	5m (16.4 feet) standard Custom lengths available in 10m increments, starting at 10m
	Minimum bend radius	152.4 mm (6 inches)
	Temperature	–40°C to +70°C
	Flame resistance	Certified: CSA-C/US AWM I/II, A/B, 80C, 30V, FT1, FT2, VW-1, FT4 Rated: AWM I/II A/B 80C 30V FT4

Table 2. General specifications

Probe dimensions

The dimensions for the Rxn-45 probe are shown below.

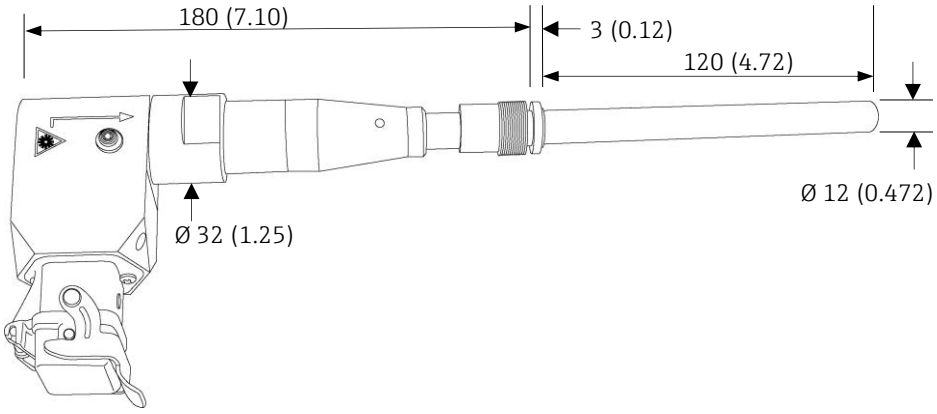

Figure 2: Rxn-45 probe dimensions

MPE : Ocular exposure

Refer to the tables below from the ANSI Z136.1 standard to calculate the Maximum Permissible Exposure (MPE) for point source ocular exposure to a laser beam.

A correction factor (C_A) may also be required and can be determined below.

Wavelength λ (nm)	**Correction Factor C_A**
400 to 700	1
700 to 1050	$10^{0.002(\lambda-700)}$
1050 to 1400	5

Table 3. Wavelength dependent correction factor C_A

Determining Maximum Permissible Exposure (MPE) for Point Source Ocular Exposure to a Laser Beam				
Wavelength *λ (nm)*	**Exposure Duration *t (s)***	**MPE Calculation**		**MPE where C_A = 1.4791**
		(J·cm⁻²)	***(W·cm⁻²)***	
785 and 993	10^{-13} to 10^{-11}	$1.5\ C_A \times 10^{-8}$	-	2.2×10^{-8} (J·cm^{-2})
	10^{-11} to 10^{-9}	$2.7\ C_A\ t^{0.75}$	-	Insert time (*t*) and calculate
	10^{-9} to 18×10^{-6}	$5.0\ C_A \times 10^{-7}$	-	7.40×10^{-7} (J·cm^{-2})
	18×10^{-6} to 10	$1.8\ C_A\ t^{0.75} \times 10^{-3}$	-	Insert time (*t*) and calculate
	10 to 3×10^{4}	-	$C_A \times 10^{-3}$	1.4971×10^{-3} (W·cm^{-2})

Table 4. MPE for ocular exposure with 785 nm or 993 nm laser emission

MPE: Skin exposure

Refer to the table below from the ANSI Z136.1 standard to calculate the MPE for skin exposure to a laser beam.

Maximum Permissible Exposure (MPE) for Skin Exposure to a Laser Beam				
Wavelength ***λ (nm)***	**Exposure Duration** ***t (s)***	**MPE Calculation**		**MPE where** C_A **= 1.4791**
		(J·cm⁻²)	***(W·cm⁻²)***	
785 and 993	10^{-9} to 10^{-7}	2 C_A x 10^{-2}	-	2.9582×10^{-2} ($J \cdot cm^{-2}$)
	10^{-7} to 10	1.1 C_A $t^{0.25}$	-	Insert time (t) and calculate
	10 to 3×10^4	-	0.2 C_A	2.9582×10^{-1} ($W \cdot cm^{-2}$)

Table 5. MPE for skin exposure with 785 nm or 993 nm laser emission

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