MOLECULAR SPECTROSCOPY

OilExpress System

User's Guide

PerkinElmer®

Release History

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Contents

Introduction

About this Manual

This manual contains the following sections:

- Introduction
- Warnings and Safety Information
- Unpacking and Installation
- Background to Used Oil Analysis
- Routine Maintenance and Troubleshooting
- Index

Using this Guide

This guide tells you how to install and maintain the OilExpress System; we recommend that you use it as follows:

1. Read *Warnings and Safety Information* on page 23 and this section before using your OilExpress System.
2. Read *The OilExpress System* on page 10, to learn about the analyzer.
3. Follow the procedures in *Unpacking and Installation* on page 37.
4. Read the *Maintenance Schedule* on page 76 to learn what maintenance the OilExpress System requires.
5. Read *Background to Used Oil Analysis* on page 69 to learn about sample preparation and the information that can be obtained by analyzing used oils.

You should use this guide in conjunction with the documentation supplied with your spectrometer.

Conventions

Conventions Used in this Manual

Normal text is used to provide information and instructions.

Bold text refers to text that is displayed on the screen.

UPPERCASE text refers to keys on the PC keyboard. '+' is used to show that you have to press two keys at the same time, for example, ALT+F.

Part Numbers

All eight-digit numbers are PerkinElmer part numbers unless stated otherwise.

Notes, Warnings and Cautions

Three terms, in the following standard formats, are also used to highlight special circumstances and warnings.

NOTE: A note indicates additional, significant information that is provided with some procedures.

CAUTION	*We use the term **CAUTION** to inform you about situations that could result in **serious damage to the instrument** or other equipment. Details about these circumstances are in a box like this one.*
D	***Caution (Achtung)*** *Bedeutet, daß die genannte Anleitung genau befolgt werden muß, um einen **Geräteschaden** zu vermeiden.*
DK	***Caution (Bemærk)*** *Dette betyder, at den nævnte vejledning skal overholdes nøje for at undgå en **beskadigelse af apparatet**.*
E	***Caution (Advertencia)*** *Utilizamos el término **CAUTION** (ADVERTENCIA) para advertir sobre situaciones que pueden provocar **averías graves en este equipo** o en otros. En los recuadros como éste se proporciona información sobre este tipo de circunstancias.*
F	***Caution (Attention)*** *Nous utilisons le terme **CAUTION** (ATTENTION) pour signaler les situations susceptibles de provoquer de **graves détériorations de l'instrument** ou d'autre matériel. Les détails sur ces circonstances figurent dans un encadré semblable à celui-ci.*
I	***Caution (Attenzione)*** *Con il termine **CAUTION** (ATTENZIONE) vengono segnalate situazioni che potrebbero arrecare **gravi danni allo strumento** o ad altra apparecchiatura. Troverete informazioni su tali circostanze in un riquadro come questo.*
NL	***Caution (Opgelet)*** *Betekent dat de genoemde handleiding nauwkeurig moet worden opgevolgd, om **beschadiging van het instrument** te voorkomen.*
P	***Caution (Atenção)*** *Significa que a instrução referida tem de ser respeitada para evitar a **danificação do aparelho**.*

WARNING

*We use the term **WARNING** to inform you about situations that could result in **personal injury** to yourself or other persons. Details about these circumstances are in a box like this one.*

D

Warning (Warnung)
*Bedeutet, daß es bei Nichtbeachten der genannten Anweisung zu einer **Verletzung** des Benutzers kommen kann.*

DK

Warning (Advarsel)
*Betyder, at brugeren kan blive **kvæstet**, hvis anvisningen ikke overholdes.*

E

Warning (Peligro)
*Utilizamos el término **WARNING** (PELIGRO) para informarle sobre situaciones que pueden provocar **daños personales** a usted o a otras personas. En los recuadros como éste se proporciona información sobre este tipo de circunstancias.*

F

Warning (Danger)
*Nous utilisons la formule **WARNING** (DANGER) pour avertir des situations pouvant occasionner des **dommages corporels** à l'utilisateur ou à d'autres personnes. Les détails sur ces circonstances sont données dans un encadré semblable à celui-ci.*

I

Warning (Pericolo)
*Con il termine **WARNING** (PERICOLO) vengono segnalate situazioni che potrebbero provocare **incidenti alle persone**. Troverete informazioni su tali circostanze in un riquadro come questo.*

NL

Warning (Waarschuwing)
*Betekent dat, wanneer de genoemde aanwijzing niet in acht wordt genomen, dit kan leiden tot **verwondingen** van de gebruiker.*

P

Warning (Aviso)
*Significa que a não observância da instrução referida poderá causar um **ferimento** ao usuário.*

The OilExpress System

The OilExpress System is optimized for the determination of lubricant degradation products. Based on infrared spectroscopy, the system is capable of measuring the following parameters in lubricants:

- Soot loading
- Anti-wear additive depletion
- Glycol
- Water
- Nitration
- Oxidation
- Sulfonation
- Fuel contamination

A Guided Tour of the OilExpress System

Figure 1 The OilExpress System

The PerkinElmer OilExpress System (Figure 1) is a bench-top instrument that provides all the following in one self-contained unit:

- A spectrometer, fitted with a sample shuttle.

NOTE: The spectrometer may be a Frontier IR System, Spectrum 100 or 400 Series, or Spectrum One instrument. For full details on how to install and use your spectrometer, refer to the documentation supplied with your instrument.

- A Liquid Autosampler designed to analyze up to 60 samples an hour.
- A water-resistant flowcell.

The system is controlled by dedicated oil analysis OilExpress software resident on a PC.

NOTE: See the help system available from the **Help** menu in the OilExpress software, which includes a tutorial and full information on using the software.

Power Switch and Communications Ports

The power switch, AC power cable connector, and communications ports are on the rear of the spectrometer. The power switch is marked I/O (on/off).

The power switch, AC power cable connector, and communications ports are located on the left-hand side of the Autosampler (see Figure 2).

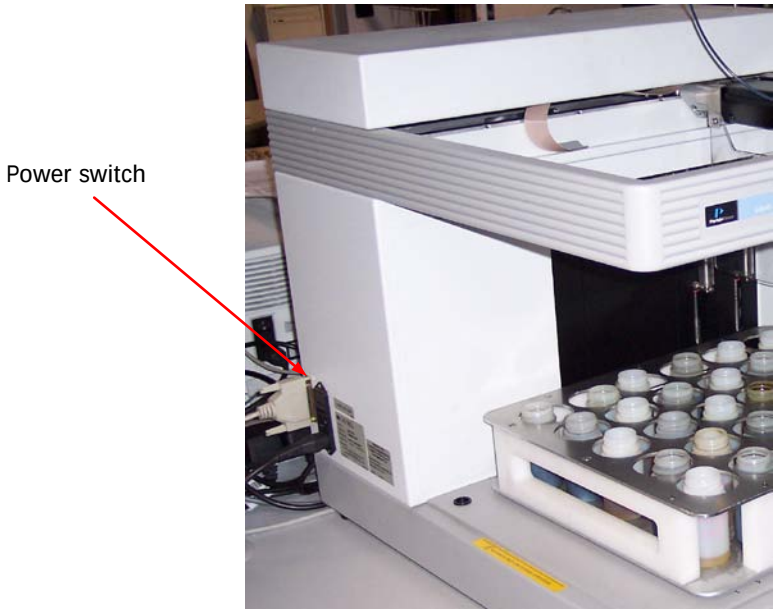


Figure 2 Location of the Autosampler power switch

The spectrometer is connected to a PC, either point-to-point or over a network.

The Liquid Autosampler module is connected to the same PC via an RS232 link.

The Liquid Autosampler

The OilExpress System uses a Liquid Autosampler to enable the rapid sampling of up to 60 oil samples per hour. Figure 3 shows a general view of the Liquid Autosampler.

The Liquid Autosampler provides:

- Minimal sample carry-over by flushing the needle and flowcell with solvent.
- A 2-port flowcell that is designed for the analysis of viscous liquids.
- Flexible sample presentation: a rack that holds 30 sample bottles, or test tube racks with a capacity of 240.
- Solvent bottle.
- Two high-resolution syringe pumps to provide robust, reliable liquid handling.

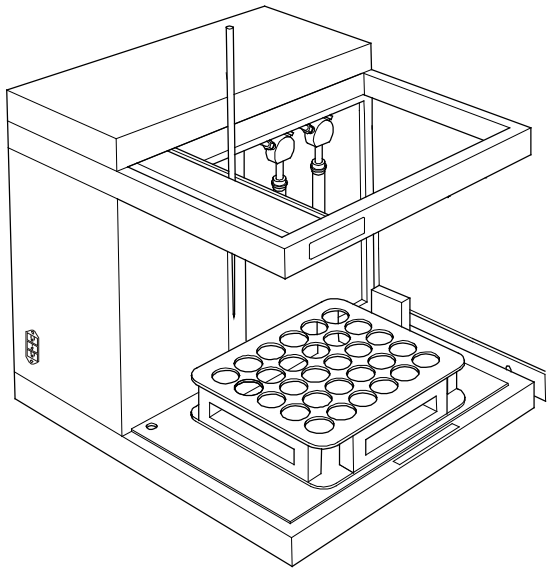


Figure 3 The liquid autosampler

X – Y – Z Arm

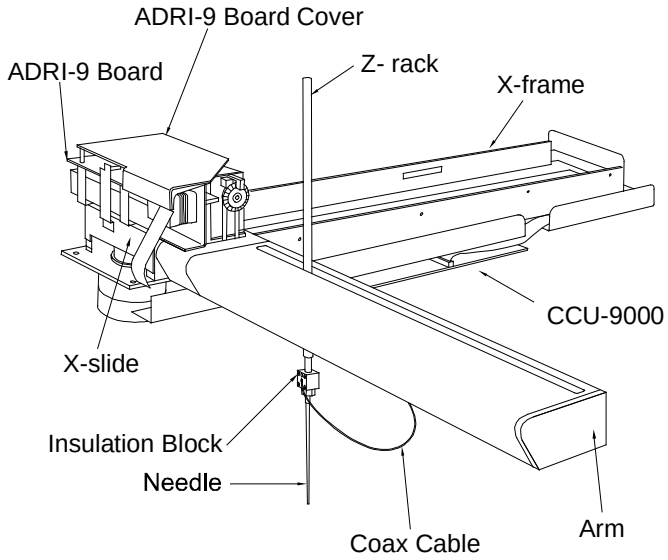


Figure 4 X – Y – Z arm mechanism

The X – Y – Z arm movements are controlled by stepper motors linked by drive belts.

Pumps

The Autosampler uses two syringe pumps. These pumps are located on the back panel of the auto stepper motor driven syringe pump (Figure 5). The pump consists of a syringe drive, a valve drive, and control electronics. The head of the syringe is attached to the valve assembly that controls the input and output of the fluid path. The plunger of the syringe is attached to the syringe drive that moves the plunger up and down.

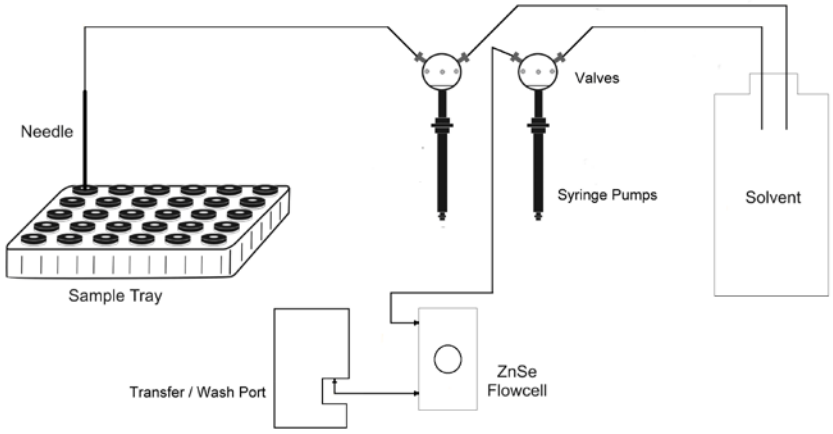


Figure 5 The sample pump

Sample Injection/Wash Port

The Sample Injection/Wash Port (Figure 6 and Figure 7) consists of a waste transfer and port. After completion of a liquid handling function, the excess sample is discarded in the waste port. The probe is then moved to the wash port for cleaning. Washing is accomplished by pumping wash fluid through the probe. The fluid then flows around the outside of the probe and overflows into the waste port. The waste fluid then travels by gravity out of the waste tubing to a waste reservoir located below the instrument.

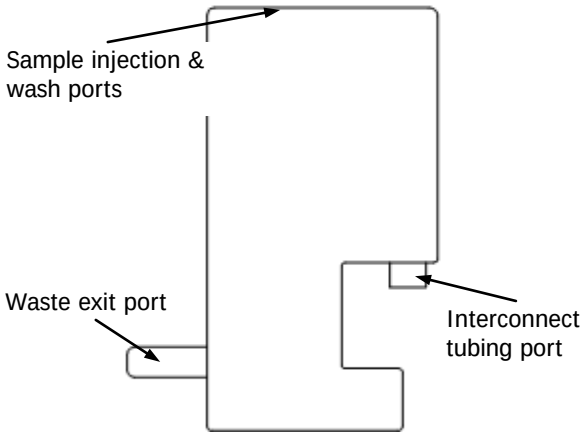


Figure 6 Sample injection and wash ports (side view)

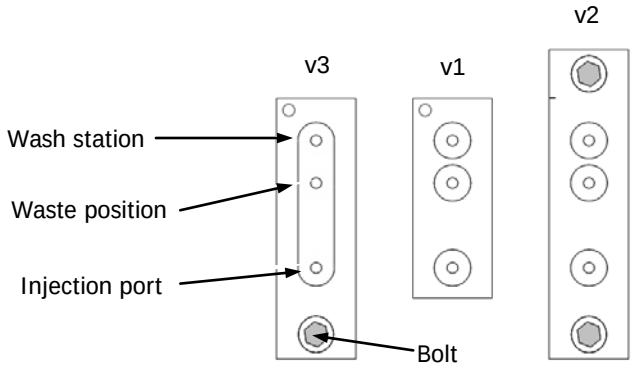


Figure 7 Sample injection and wash ports (top view)

The transfer port is used to transfer the sample to the flowcell located in the sample compartment of the spectrometer. The transfer port consists of a nylon fitting into which the sample probe is lowered.

Sampling Probe/Needle

The sample is drawn through the stainless steel needle and delivered to the flowcell via the transfer port. The needle is cleaned in the wash port: the solvent flows down inside the needle, and then is forced up around the outside and to waste.

Sample Rack

A 30-bottle sample rack is supplied as shown in Figure 8.

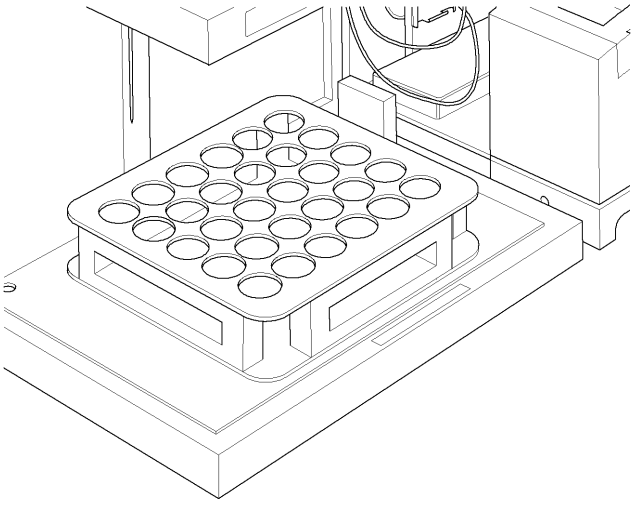


Figure 8 Autosampler sample rack

Solvent Bottle

WARNING

In the event of a solvent spillage, isolate the power to the OilExpress System immediately and then clean up the solvent spill. The system can then be powered up but the spectrometer should be allowed to stabilize for at least two hours before measurements are taken.

The recommended solvent for the OilExpress System is heptane. This should be aspirated from a supply adhering to laboratory safety standards that advise on its safe storage, handling, use and disposal.

If using the solvent bottle supplied with the OilExpress System (Figure 9), the following is recommended:

- The solvent bottle should be re-filled away from the OilExpress System, in a well-ventilated area, and precautions should be taken against static discharge.
- The bottle lid should be used at all times. The solvent bottle lid should be correctly fitted to the bottle during operation of the OilExpress System.
- The bottle should be stored to the rear of instrumentation at a location where it will not be knocked accidentally.

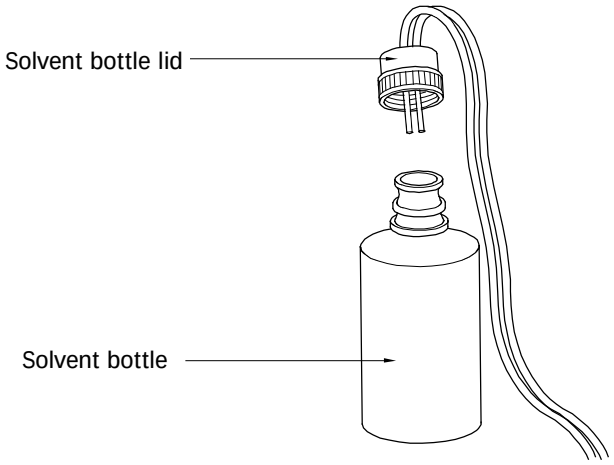


Figure 9 Solvent bottle

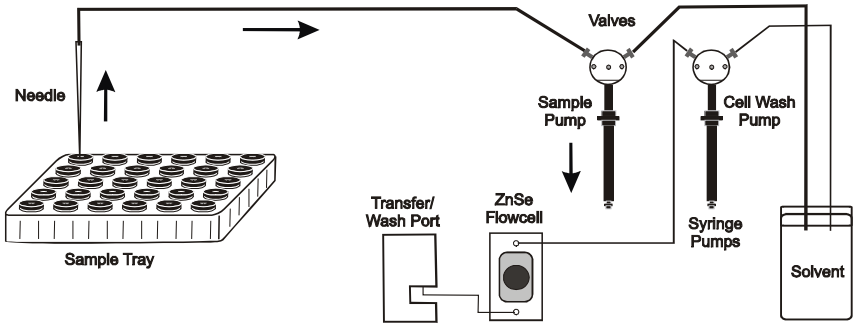
Overview of the Sampling Procedure

1. At the start of an analysis, the wash volume of solvent is drawn up by each pump.

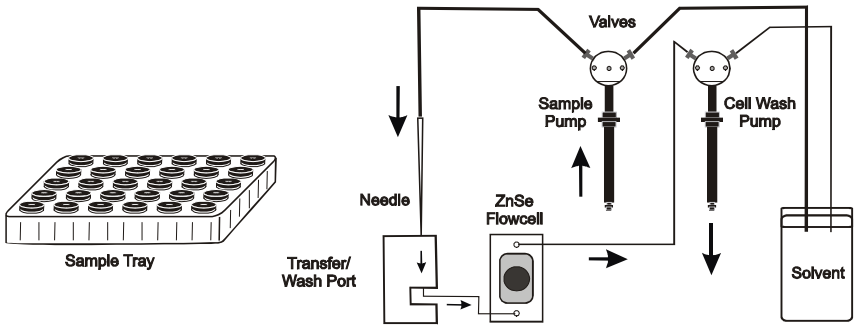
2. The sample pump valve switches to the needle and the cell pump switches to the cell, and the solvent is dispensed.

3. The needle is lowered into the sample and the sample is aspirated by the drawing down of the sample pump.

   The default volume aspirated is 3.5 ml.



4. The needle then moves to the transfer port.



5. The sample pump dispenses the sample to the cell.

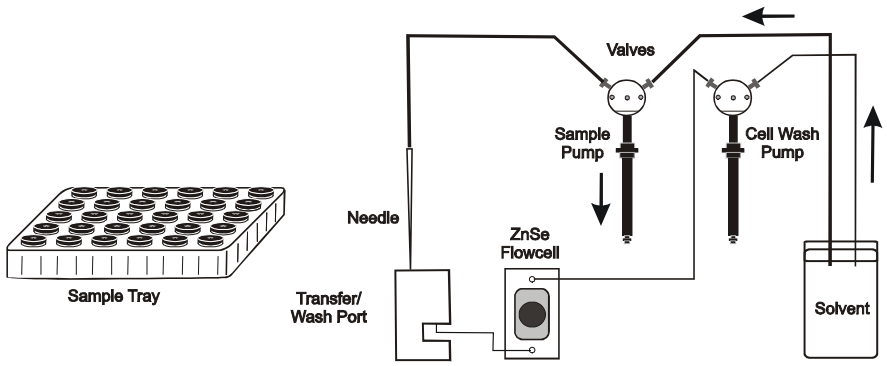
   Only 2.1 ml of sample is dispensed to the cell.

   To aid the transfer of the viscous liquid and prevent pressure build up, the cell pump is simultaneously drawn back by the same volume.

6. The OilExpress software performs a sample detection.

7. When the sample has been successfully detected the needle moves to the waste port to dispense the remaining sample.

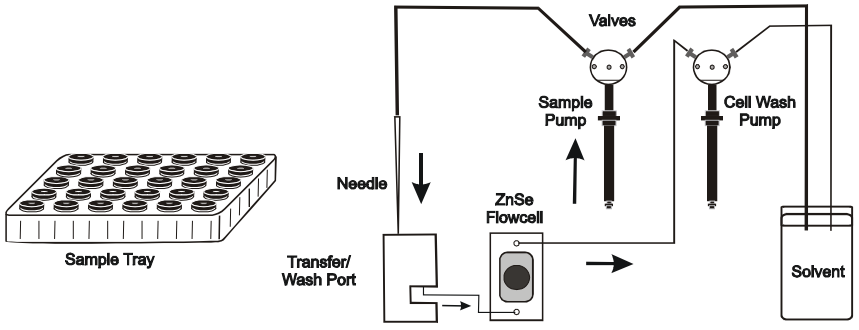
8. The sample pump valve switches position so that the pump is connected to the solvent reservoir.



9. The pump aspirates the solvent.

10. The sample pump valve then switches back to the needle.

11. The needle moves and lowers into the wash port.



12. The sample pump dispenses the solvent to flush out the tubing and the needle.
    When the needle has been flushed the next sample can be aspirated.

13. When OilExpress has completed scanning the sample, the cell pump valve switches to the cell and the pump moves to push the sample back through the cell and back through the transfer port where it then flows to the adjacent wash port.

14. The cell pump valve switches to the reservoir and aspirates solvent.

15. The cell pump valve then switches back to the cell and the pump moves up to flush the cell and the tubing.
    Waste from this process flows back through the cell and the transfer port to waste.

Analyzer Measurement

Analyzer Sample Compartment

WARNING	*DO NOT use the OilExpress System when the sample compartment lid is fitted. Flammable vapor may seep through instrument seals and gaskets and accumulate under the lid, where it could cause a fire or explosion hazard.*

CAUTION	*The sample compartment windows may be composed of a hygroscopic material, such as KBr; which, although coated, can be damaged by high levels of humidity. Refer to the documentation supplied with your spectrometer for details.* *If you spill liquid in the sample compartment, wipe it up quickly.*

CAUTION	*Relative humidity higher than 80% can damage the windows of the sample compartment.*

The sample compartment (Figure 10) is located at the front of the instrument.

Figure 10 Sample compartment of a Frontier IR System

- The infrared beam enters the compartment through an aperture on the left. After passing through the sample, it enters the detector area through an aperture on the right side of the sample compartment.
- A sample shuttle is installed in the sample compartment. The sample shuttle is used to move the flowcell of the Liquid Autosampler in and out of the beam.

2-Port Flowcell

The 2-port flowcell (Figure 11) is used in a sample shuttle so that a background spectrum can be collected regularly if sampling times are long, or to compensate for changing environmental conditions. The sample shuttle moves the flowcell in and out of the beam between collecting a background and sample spectrum.

Flowcells are fitted with zinc selenide (ZnSe) windows for use with mid infrared spectrometers. Each flowcell is fitted with two windows.

Figure 11 The 2-port flowcell

Filling and emptying the flowcell

In the 2-port flowcell, the sample enters the flowcell at the bottom of the cell. When the cell is emptied, the sample is pushed back out of the bottom of the flowcell, up through the transfer port and evacuates to waste by gravity.

Rinsing the flowcell

When the flowcell is rinsed, the solvent enters the flowcell at the top of the cell, and leaves it at the bottom, then passes through the transfer/wash port to waste.

FT-IR Liquid Autosampler for Oils: Specifications

Sample Viscosity Range	4–1000 cSt (centiStokes)
Sample Throughput	Approximately 50 per hour for 200 cSt samples
Sample Carry-over	<0.1%
Wash Solvent Carry-over	1% typical
Capacity	30 × 4 oz bottles / 240 × 16 mm vials
Minimum Sample Volume	4 ml
Flowcell – mid infrared	Flow-through transmission with ZnSe windows: 0.1 mm pathlength

Warnings and Safety Information

OilExpress System Safety Summary

The PerkinElmer OilExpress System has been designed to comply with a wide variety of international standards governing the safety of laboratory equipment. In routine use, the OilExpress System poses virtually no risk to you. If you take some simple, common sense precautions, you can make sure that you maintain the continued safe operation of the OilExpress System.

DO make sure that the OilExpress System is properly connected to the electrical supply; in particular make sure that the ground (earth) is securely connected.

DO take care with solvents: heptane is highly flammable. Remove the solvent bottle and move it away from the OilExpress System before you fill it. Always keep the lid on the solvent bottle.

DO disconnect the electrical power cable before opening the main cover of the spectrometer.

DO keep the OilExpress System dry. Avoid spilling liquid into the OilExpress System. Clean all external spills immediately. If anything that is spilled enters the main body of the OilExpress System, switch off the power and call a PerkinElmer Service Engineer.

DO NOT stare into the laser beam. The spectrometer contains a low power, visible (red) laser; momentary exposure to the beam is not dangerous, but deliberate, direct viewing of the beam along its axis could damage your eye.

DO NOT use the OilExpress System when the sample compartment lid is fitted. Flammable vapor under the lid could be a fire or explosion hazard.

DO NOT use a flammable gas to purge the spectrometer. The spectrometer contains a hot source, and a fire or explosion will result. Only use clean, dry, oil-free nitrogen or air to purge the instrument.

DO NOT place hands beyond the line at the front of the Autosampler enclosure whilst operating the OilExpress System.

Read the more detailed information on warnings and safety in the following pages, and in the documentation supplied with your spectrometer, to ensure the safe operation of the instrument.

General Safety

The OilExpress System has been designed and tested in accordance with PerkinElmer specifications and in accordance with the safety requirements of the International Electrotechnical Commission (IEC). The spectrometer conforms to IEC publication 61010-1 (“Safety requirements for electrical equipment for measurement, control, and laboratory use”) as it applies to IEC Class 1 (earthed) appliances and therefore meets the requirements of EC low voltage directive 2006/95/EC.

If the instrument is used in a manner not specified by the manufacturer, the protection provided by the instrument may be impaired. Only use the OilExpress System indoors and under the following conditions:

Temperature: 15 °C to 35 °C
Relative Humidity: 80% maximum (non–condensing)

If possible, avoid any adjustment, maintenance and repair of the opened, operating instrument. If any adjustment, maintenance and repair of the opened, operating instrument is necessary, this must only be done by a skilled person who is aware of the hazard involved.

Whenever it is likely that the OilExpress System is unsafe make it inoperative. The OilExpress System may be unsafe if it:

- Shows visible damage.
- Fails to perform the intended measurement.
- Has been subjected to prolonged storage in unfavorable conditions.
- Has been subjected to severe transport stresses.

WARNING

Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

If the equipment is used in a manner not specified herein the protection provided by the equipment may be impaired.

The OilExpress System has been designed to be safe under the following environmental conditions:

- Indoor use.
- Altitude up to 2000 m (above mean sea level).
- Ambient temperatures of 5 °C to 40 °C.
- A maximum ambient relative humidity of 80% for temperatures up to 31°C, decreasing linearly to 50% relative humidity at 40 °C.
- Mains supply fluctuations not exceeding ±10% of the nominal voltage.

Location and Ventilation

To allow for adequate cooling, the OilExpress System should not be sited near to room heating equipment, for example, central heating radiators.

During operation, there should be a minimum gap of:

- 6 inches (15 cm) between any surface and the cooling louvers at the rear of the spectrometer.
- 3 inches (7 cm) between the OilExpress System and adjacent equipment.
- 1 inch (2.5 cm) between any wall or obstructing surface and the ventilation panel on the back of the Autosampler.

WARNING

Make sure that the switches at the electrical supply inlet on the rear and side of the OilExpress System are not obstructed.

Mechanical Hazards

WARNING

Whenever the autosampler is in operation there is the risk of injury from moving mechanical parts. The autosampler is designed for automatic hands-off operation only. Never reach into the autosampler workspace when the autosampler is in operation.

Electrical Safety

- Connect both units comprising the OilExpress System to a power supply line that includes a switch or other means of disconnection from the electricity supply.
- Only plug the OilExpress System into an electricity supply socket that is provided with a protective earth connection.
- When fuses need replacing, use only those with the required current rating and of the specified type. Do not use makeshift fuses and do not short-circuit fuse holders. On the Autosampler, replace both fuses if one blows as the second one will be weakened.
- When the OilExpress System is connected to its electricity supply, terminals may be live and the removal of covers other than those that can be removed by hand is likely to expose live parts.
- Capacitors inside the OilExpress System may still be charged even if the instrument has been disconnected from all voltage sources.

- The OilExpress System must be disconnected from all voltage sources before it is opened for any adjustment, replacement and maintenance, or cleaning up of any major liquid spills.

- Do not touch any switches or outlets with wet hands.

WARNING

Any interruption of the protective earth conductor inside or outside of any components comprising the OilExpress System or disconnection of the protective earth terminal can make the instrument dangerous.

The OilExpress System has:

- An IEC Pollution Degree 2 classification – usually only non-conductive atmospheric pollution of the equipment occurs; occasionally, however, a temporary conductivity caused by condensation must be expected.

- An IEC Insulation class I rating for external circuits – only connect equipment that meets the requirements of IEC 61010-1, IEC 60950 or equivalent standards.

The instrument is designed to be safe under transient overvoltages typically present on the MAINS supply.

NOTE: The normal level of transient overvoltages is impulse withstand (Overvoltage) category II of IEC 60364-4-443.

Samples and Waste

Samples

When using the flowcell, to ensure that the sample will flow through the flowcell the maximum particle diameter must not exceed 50 µm.

Solvent

The recommended solvent for use in the OilExpress System is heptane. Observe the warnings in *Use of Flammable Solvents and Samples* on page 32 when using heptane.

Waste

DO position the waste container on a surface that is at least 90 cm (36 inches) below the bench on which the OilExpress System is located because the flow of waste relies on gravity.

DO NOT immerse the ends of the tubes in the waste.

Disposal of waste

Observe local and national regulations when disposing of waste from the OilExpress System.

Laser Safety Regulations

The OilExpress System is a CDRH Class I, BS EN 60825-1/IEC 60825-1 Class 1 laser product as defined by IEC 60825-1. The optical module contains a Class 2 Helium Neon (HeNe) laser, which emits visible, continuous wave radiation at a wavelength of 633 nm and has a maximum output power of 1 mW. Some diffuse HeNe laser radiation, within Class 1 limits, emerges from:

- The window in the left hand side of the sample compartment when an internal beampath is selected.
- An external beam port when the beam port cover is removed, no accessory is fitted at the port, and the beampath to the port is selected.

WARNING

Do not stare into any laser beam. Staring into a laser beam (intrabeam viewing) can cause permanent damage to your eyes.

The laser is automatically shut down when the main cover of the instrument is raised.

WARNING

Do not attempt to override or modify the interlock system.

Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

The instrument complies with the following laser safety regulations:

1. 21 CFR Part 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No.50 dated 24 June 2007. Administered by the Center for Devices and Radiological Health, U.S. Department of Health and Human Services.
2. EN 60825-1:2007 – “Safety of laser products – Part 1: Equipment classification and requirements”.

For further information on the safe use of your spectrometer, refer to the documentation supplied with the instrument.

Warning Labels

When this label is attached to an instrument it means refer to the manual in order to find out the nature of the potential hazard and any actions which have to be taken.

Autosampler Labels

Labels are fixed to the Autosampler in the locations shown in Figure 12 & Figure 13.

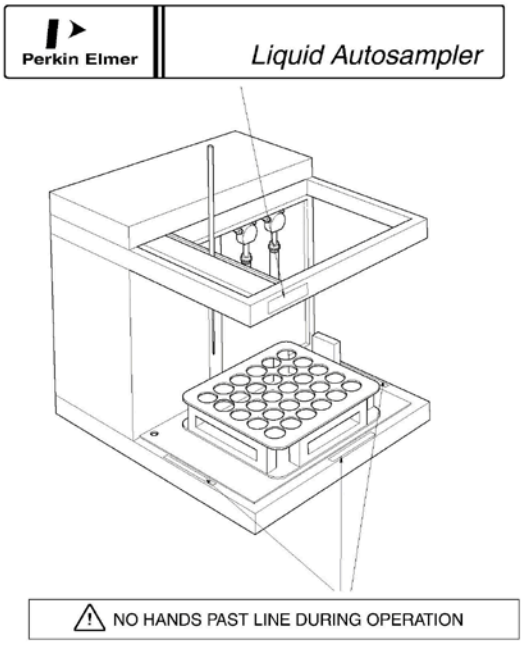


Figure 12 Autosampler labels (front)

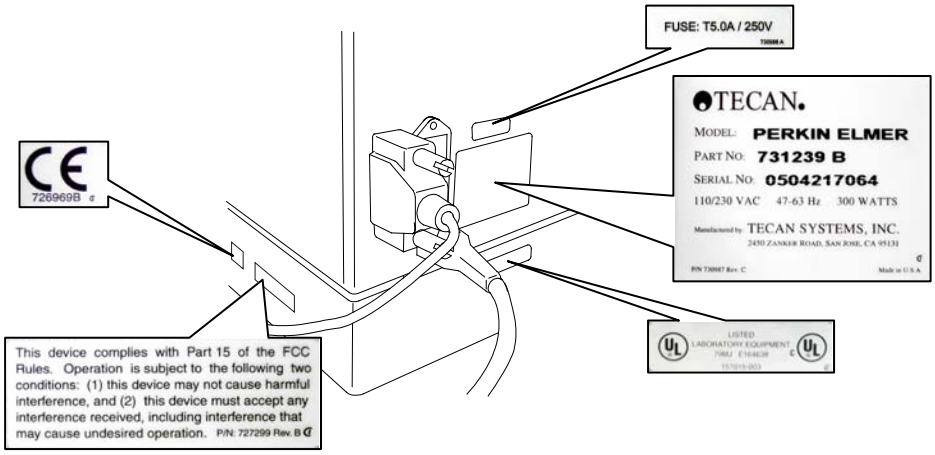


Figure 13 Autosampler labels (rear and left side)

Warning Signs on the Instrument

Caution, hot surface

Caution, risk of electric shock

Caution, laser radiation hazard

Caution risk of danger.

Refer to accompanying documents in all cases where this symbol is used to find out the nature of the potential HAZARD and any actions which have to be taken.

EMC Compliance

EC Directive

The OilExpress System has been designed and tested to meet the requirements of the EMC Directive 2004/108/EC. The OilExpress System complies with the EMC standard EN 61326 (EMC standard for electrical equipment for measurement, control and laboratory use).

FCC Rules and Regulations

This product is classified as a digital device used exclusively as industrial, commercial, or medical test equipment. It is exempt from the technical standards specified in Part 15 of the FCC Rules and Regulations, based on Section 15.103 (c).

Use of Flammable Solvents and Samples

WARNING

The spectrometer contains a hot source and contact with flammable vapors may cause an explosion. When working with flammable solvents or samples, particularly during unattended operation with flow-cells, it is recommended that the instrument optics area should be continuously purged with dry air or nitrogen to maintain a positive pressure and prevent flammable vapor entering the instrument.

WARNING

DO NOT use the OilExpress System when the sample compartment lid is fitted. Flammable vapor may seep through instrument seals and gaskets and accumulate under the lid, where it could cause a fire or explosion hazard.

WARNING

If flammable solvents or samples are spilled on the instrument and there is any possibility that they have entered the interior (by coming into contact with cover gaskets for example) then the instrument must be switched off immediately and disconnected from the power supply. The optics area should then be thoroughly purged with dry air or nitrogen, or the main cover should be opened to thoroughly ventilate the optics area before proceeding.

WARNING

Flammable solvents or samples should not be stored on or near the instrument. Handling of such materials during preparation should be performed in a safe area away from the instrument such as a fume cabinet.

WARNING

Some chemicals used with this instrument may be hazardous or may become hazardous after completion of an analysis. The responsible body (for example, the Laboratory Manager) must take the necessary precautions to make sure that the surrounding workplace is safe and that the instrument operators are not exposed to hazardous levels of toxic substances (chemical or biological) as defined in the applicable MSDS (Material Safety Data Sheets) or OSHA (Occupational Safety and Health Administration (United States)), ACGIH (American Conference of Governmental Industrial Hygienists (United States)), or COSHH (Control Of Substances Hazardous to Health (United Kingdom)) documents. Venting for fumes and disposal of waste must be in accordance with all national, state and local health and safety regulations and laws.

WARNING

We recommend that you use heptane as the rinse solvent in the OilExpress System. This highly flammable solvent presents no hazard during routine use of your OilExpress System, but:

- *DO clean up leakages and spillages immediately and thoroughly.*
- *DO move the solvent bottle away from the OilExpress System before you fill it.*
- *DO always keep the lid on the solvent bottle.*
- *DO NOT allow the syringe pumps to run dry; make sure that there is always sufficient solvent in the solvent bottle.*

WARNING

DO make sure that the waste tubing is not blocked and that it outlets to a suitable waste container which stands on a surface at least 90 cm below the bench on which the OilExpress System is located.

The end of the waste tubing should not be immersed in the waste material.

DO read and observe the information supplied with the solvent.

Heptane

Safety information for heptane is summarized below. See the Materials Safety Data Sheet (MSDS) for heptane, supplied by your local Safety Officer, for full details.

Physical data

Description	Clear, colorless liquid with a faint gasoline-like odor
Boiling point	98 °C
Specific gravity	0.6837
Solubility in water	Insoluble
Vapor pressure	40 mmHg at 20 °C
Vapor density	3.45

Fire and explosion hazard

Heptane is flammable (USA definition)/highly flammable (European definition)	
Flash point	-4 °C
Explosive limits	1.05 - 6.7 %
Ignition temperature	223 °C
Firefighting measures	Extinguish fire with foam, dry powder, carbon dioxide or vaporizing liquid

Storage and handling

When storing heptane, observe local and national regulations. Keep containers tightly closed.

When handling heptane, wear safety goggles and protective gloves. Do not breathe the vapor, and avoid contact with eyes, skin and clothing.

Material Safety Data Sheets

WARNING

Some of the materials described in these procedures are hazardous. Appropriate safety equipment and clothing should be used when handling them. See the Materials Safety Data Sheets (MSDS) supplied by your local Safety Officer for details.

They must be disposed of with care, following your laboratory procedures.

You can search for up-to-date copies of safety data sheets on materials, such as ZnSe, used in PerkinElmer products that are known to have safety issues from the Technical Resources section of the PerkinElmer website. The MSDS information is available in a range of languages, and includes data items required in specific national, supra-national and state jurisdictions.

To obtain a safety data sheet for a particular compound, follow the steps described below.

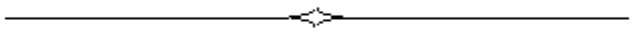
NOTE: To read MSDS .pdf files you will need Adobe Reader 5.0 or later. An installation of this software is available on the *Software Utilities CD*.

1. Launch your web browser and navigate to the PerkinElmer web site:
   www.perkinelmer.com
   If you are not redirected automatically you may have to select the home page appropriate to your location.

2. Search for the term MSDS using the search box located at the top of the home page.
   The **Search for Material Safety Data Sheets (MSDS)** page is displayed.

3. Enter the key words for the compound, in the **Product name** box, and then click **Go**.
   A full list of all MSDS documents that refer to the compound is displayed.

4. Select the MSDS document you want to view.



Unpacking and Installation

Overview

Installation of the OilExpress System and OilExpress software will be performed by a PerkinElmer Service Engineer. The installation procedure is summarized below.

- Unpack the Autosampler
- Unpack and install the sample shuttle in your spectrometer
- Connect the Autosampler
- Install OilExpress software
- Configure the OilExpress system
- Calibrate the OilExpress system

NOTE: For details of how to unpack and install your spectrometer, please refer to the documentation supplied with your instrument.

Instrument Requirements

NOTE: Read the warnings and safety information at the start of this manual before installing the OilExpress System. They contain important information.

Electrical requirements

- The OilExpress System can operate on electricity supplies of 50 or 60 Hz and on voltage ranges of between 100 and 120 V or between 220 and 240 V.
- The line supply must be within 10% of the nominal voltage.
- The power rating of the Autosampler is 300 W.
- If possible, do not connect the OilExpress System to circuits that have heavy-duty equipment, such as large motors, connected.
- If possible, do not use photocopiers, discharge lamps, radio transmitters, and other equipment with large or frequent transient loads on the same supply circuit.

Environment

To obtain the best performance from your OilExpress System:

- Place the OilExpress System in an environment that is relatively dust-free.
- Make sure that the bench top is free from vibrations or mechanical shocks.
- Do not place the OilExpress System or the PC near to room heating equipment, for example, central-heating radiators.
- Leave at least 7 cm (3 inches) from any vertical obstacle to the sides of the OilExpress System, to permit an adequate flow of cooling air.
- Make sure that there are no overhanging shelves, and no water pipes or faucets that could leak onto the OilExpress System.
- The area near the PC must be free of strong magnetic fields, direct sunlight, and heating or cooling units or ducts.

Unpacking

Unpacking the Autosampler

WARNING

The Autosampler is a heavy instrument with a basic weight of approximately 30 kg, so two people are required for safe handling.

Consult the local codes of practice issued by safety advisors before attempting to lift it.

Take care not to injure yourself or others, or to drop the Autosampler.

- When you receive the instrument, look at the exterior of the container for possible shipping damage. Check for the following items:
  - Water damage or discoloration
  - Cuts or gashes
  - Collapsed corners
  - Crushed top or sides
  - Other physical damage

NOTE: If any of the above items are found, contact PerkinElmer and the shipping agent immediately.

Before unpacking the Autosampler, make sure that there is sufficient space to lay out the instrument and accessories. This makes checking the contents of the box against the packing list easier. Follow the steps below to prevent damage to the instrument:

1. Remove the plastic shrink-wrap.
2. Cut the two (2) bands.
3. Lift off the top of the shipping carton.
4. Empty the small accessories from the end sections of the carton.
5. Gently lift the entire upper portion of the inner container and set it aside.
6. Remove the styrofoam cushions on top of the instrument.
7. Remove instrument from the shipper and place it on a work surface.

Do not lift the Autosampler by its arm guard.

CAUTION

8. Inspect instrument for any physical damage.

9. Open the box of accessories and place the contents on an open surface.

10. Check to make sure that all parts have been received.

NOTE: If any parts are missing from the packing list, contact PerkinElmer immediately.

Unpacking and Installing the Sample Shuttle

The sample shuttle accessory can be simply installed into the sample compartment of the spectrometer.

1. Unpack the sample shuttle from its box.

2. Rest the back of the sample shuttle accessory on the ledge in the sample area and slide it into position.

   Push it firmly home to ensure that the multiway connector on the rear of the sample shuttle accessory mates properly with the spectrometer connector.

WARNING

When the sample shuttle locks into place it aligns itself, which means that the slide holder may move. Be careful that your fingers, tie, etc are not trapped by the movement.

Figure 14 Installing the sample shuttle accessory

NOTE: To remove the sample shuttle accessory, release the accessory by pulling the blue handle under its baseplate, and then slide the accessory towards you and out of the sample compartment.

Positioning the OilExpress System

WARNING

The Autosampler is a heavy instrument with a basic weight of approximately 30 kg.

Two people are required for safe handling.

Consult the local codes of practice issued by safety advisors before attempting to lift it.

Take care not to injure yourself or others, or to drop the instruments.

1. Position the Liquid Autosampler on the bench as shown below (Figure 15).

   Leave a gap of 0.5–1 cm between the Autosampler and the spectrometer. Ensure that you have space for the PC either to the right side of the spectrometer, or to the left side of the Autosampler.

Figure 15 The OilExpress System positioned for use

2. Align the Autosampler and the spectrometer so that the rear of the injection wash port and the sample shuttle are parallel.

   The spectrometer protrudes approximately 5 cm in front of the Autosampler when correctly aligned.

   Make sure that there is access to power and a waste container.

3. Place the PC in a suitable location.

4. Remove the Velcro straps and plastic cable ties around the Z-rack.

5. Remove any additional packaging and support from the Autosampler and make sure that the arm is able to move freely on all axes.

Installing the Liquid Autosampler

Electrical Connections

Power cord

1. Make sure that the Autosampler is switched off.

2. Fit the molded socket of the mains cable into the plug on the side panel of the Autosampler (Figure 16).

3. Plug the power cord into the appropriate mains electrical supply.

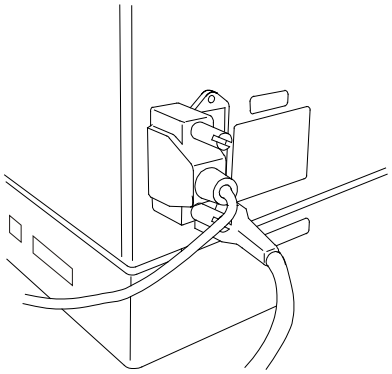


Figure 16 The side panel of the autosampler

Cable to PC

1. Attach the male connector into the DB25 receptacle on the left side of the Autosampler (Figure 16), and tighten the screws.

2. Attach the female connector of the cable to the DB9 SERIAL COMM 1 port on the back of the PC, and tighten the screws.

   If the computer has a DB25 connector, an adapter is required.

Installing the Fluid Line Support Arm

Insert the fluid line support arm into the liquid connector block on the right of the autosampler.

Figure 17 Fluid line support arm

NOTE: The Arm Shield is not installed until the remainder of the installation, including software installation and calibration has been completed.

Installing Racks (if ordered)

1. Remove and unwrap rack.
2. Place the sample rack on the pins as shown in Figure 18.

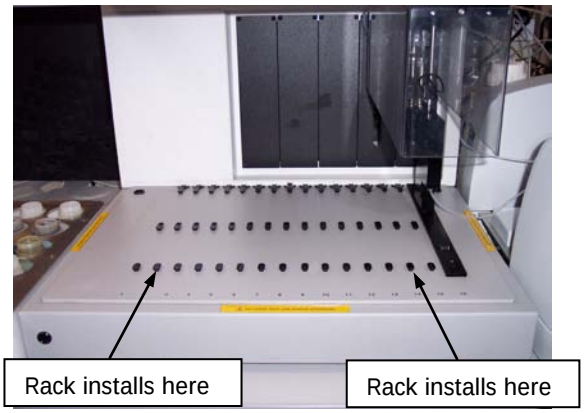


Figure 18 Installing the sample rack

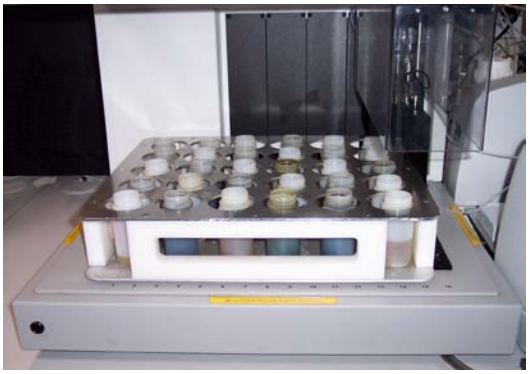


Figure 19 Sample rack

Autosampler Tubing Connections

Fluid Tubing System

1. Remove the reagent tubing (L1200556) from the accessory bag. Route the ends with the fitting through the black grommet hole on the right panel of the autosampler. Install fitting on the right valve port of each of the syringe pumps. Tighten the fitting finger tight and then tighten an additional quarter turn with a wrench.

2. Remove the interconnect tubing (L1200585) from the accessory bag. Route one end of the tubing through the black grommet hole on the right panel. Install the fitting on one end to the left valve port of the right syringe pump. Connect the fitting on the other end to the top of the 2-port flowcell. Tighten fittings as above.

3. Remove the needle tubing (L1200587) from the accessory bag. Install the end with the fitting into the left valve port of the left syringe pump. Insert the other end through the fluid line support arm (Figure 17), and then through the top of the Z-rack until it extends approximately one inch out from the lower end (Figure 21).

4. Remove the interconnect tubing (L1200557) from the accessory bag. Install the fitting on one end to the bottom of the injection\wash port (Figure 6) and the other to the bottom of the 2-port flowcell. Tighten the fitting finger-tight and then tighten an additional quarter turn with a wrench.

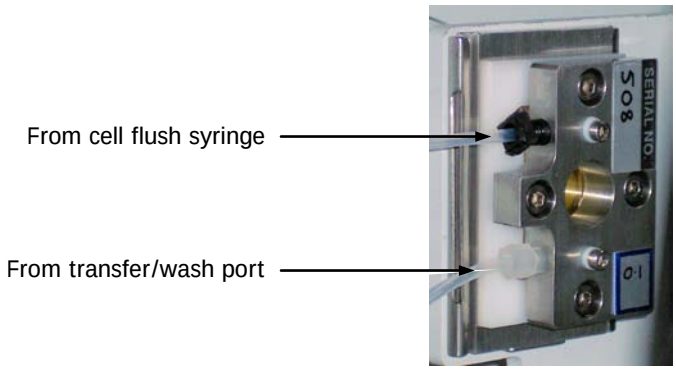


Figure 20 Connecting tubing to the 2-port flowcell

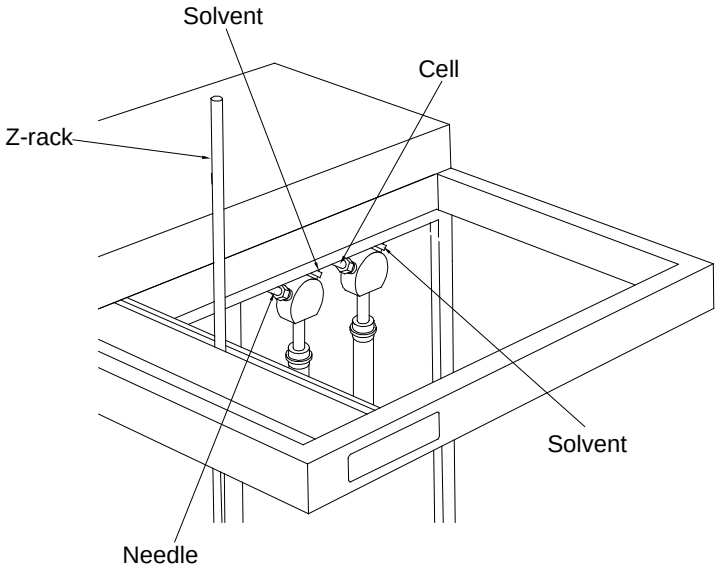


Figure 21 Tubing connections from the pumps to the 2-port flowcell

5. Remove the needle from the accessory bag. Loosen the slotted screw in the insulation block, and then insert the shorter end of the needle through the sleeve in the insulation block as far as the collar. Retighten the screw.

CAUTION	*Electrostatic discharge to the sampling probe may cause damage to the ALIDUM liquid level detector (see* Inspecting the Insulation Block/ALIDUM Cable Assembly *on page 82).*

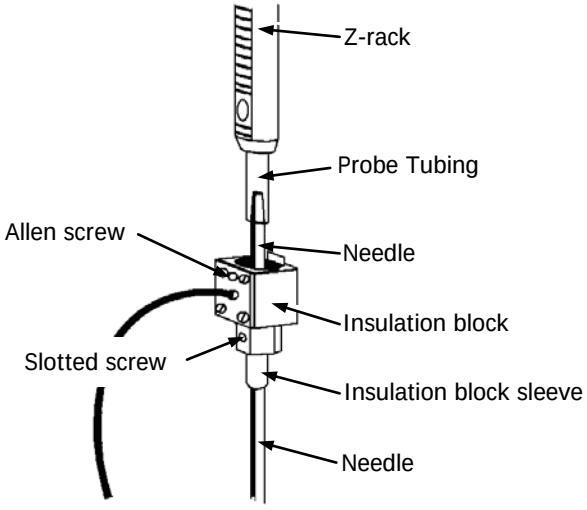


Figure 22 Connecting the needle tubing to needle

6. Push the needle tubing over the shorter end of the needle (to a minimum of 25 mm, 1 inch).

7. Loosen the Allen screw on the insulation block. Install the insulation block on the Z-rack with the insulation block sleeve facing down and the insulation block (black coax) cable on the left side. Ensure that the insulation block cable is not twisted.

8. Push the insulation block onto the Z-rack until firmly seated.

9. With an Allen wrench, tighten the insulation block set screw until it makes contact with the flat portion of the Z-rack. Do not overtighten the setscrew.

Connecting the tubing to the solvent bottle

1. Thread the tubing from top to bottom through the cap of the wash bottle as shown in Figure 23.

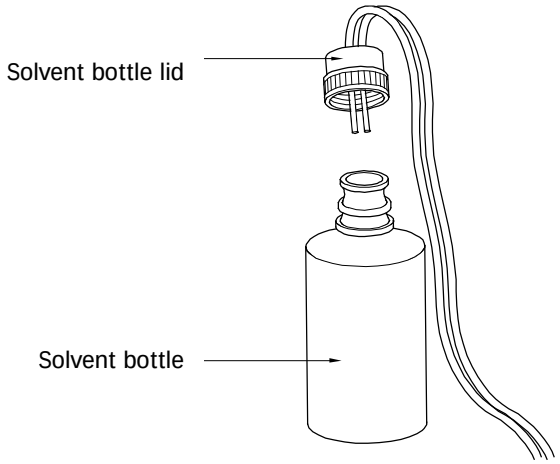


Figure 23 Connecting the solvent tubing

2. Fill the solvent bottle with solvent.

3. Screw the cap on to the solvent bottle securely.

4. Position the bottle safely, behind the instrumentation at a location where it will not be accidentally knocked.

Installing the Flowcell in the Sample Shuttle

WARNING

DO NOT use the OilExpress System when the sample compartment lid is fitted. Flammable vapor may seep through instrument seals and gaskets and accumulate under the lid, where it could cause a fire or explosion hazard.

1. Unpack the flowcell.
2. Slide the flowcell into the sample shuttle (Figure 24).
3. Make sure that the tubing cannot obstruct the optical beampath.

Figure 24 Sample shuttle accessory and flowcell fitted

Waste Container

We recommend that you use a waste container that is larger than the solvent bottle. Then, if you empty the waste container whenever you refill the solvent bottle, the waste container will not overflow.

The waste drains into the container by gravity, so the container should stand on a surface that is at least 90 cm below the bench on which the OilExpress System is located.

Fitting waste tubing

1. Attach the waste tubing to the hose connector at the rear of the transfer/wash port.
2. Insert the waste tubing into the hole on the rear right-hand side of the base plate of the Autosampler.
3. Adjust the routing of the tubing so that it is not kinked.
4. Place the other end of the waste tubing in the waste container.
   Ensure that the end will not be immersed in the waste.

CAUTION

Make sure that the ends of the tubing do not become immersed in the waste or the operation of the analyzer will be impaired.

Installing the Syringe

The syringes cannot be installed until the OilExpress software has been installed.

1. Switch on the Autosampler.
2. Start the AutoSampler Utilities.
   Select **Start**, **All Programs**, **PerkinElmer Applications**, **OilExpress** and then click **AutoSampler Utilities**.
3. Log in as an Administrator.
   The User Name is **Administrator** and the Password is **Administrator**.
4. Select **Pump Diagnostics** from the File menu.
5. Click **Change Syringe**.
6. Assemble the syringe (L1200552) by placing the plunger in syringe barrel and putting the syringe clamp over the Luer lock fitting.
7. Unscrew the pin from the plunger shaft.
8. Mount the syringe plunger on the plunger shaft. Line up the barrel with the Luer lock fitting. Screw the barrel onto the valve fitting while pushing upward slightly.

CAUTION	*When mounting the syringe on the valve, you must assist the Luer lock threads by pushing upward. Otherwise they may become stripped.*

9. Replace the plunger pin.
10. Rotate the syringe clamp clockwise then tighten the clamp screw.
11. Replace the plunger screw at the base of the syringe plunger.

PC Software and Hardware Requirements

This section details the minimum hardware and software requirements for the PC. To ensure successful installation of the software, please check these requirements before starting the installation.

Only if all of these criteria are met should you start to install the OilExpress software (see *Installing the OilExpress Software* on page 54).

Software Requirements

The minimum software requirements for the OilExpress System are:

- Windows 7 (32-bit), Windows Vista or Windows XP with Service Pack 2 must be installed, and you must be logged on at Administrator level.
- Internet Explorer 5.01 or later must be installed.
- Spectrum software must be installed, as described in the documentation supplied with your spectrometer on the *IR & Raman Manuals CD* (L1050002).

Hardware Requirements

The PC you install the software on must meet the following minimum specification:

- Intel® Pentium 4 processor with 500 MHz or greater clock speed, or equivalent.
- At least 256 MB of Random Access Memory (RAM).
- The capability of displaying at least High Color (16 bit) at 1024 × 768 SVGA.
- 10 GB Hard disk with at least 1 GB free space as an NTFS drive.
- CD-ROM drive.
- Ethernet network connection.
- A keyboard and PS/2®-style mouse.
- A serial port, for autosampler connection.

Upgrading from a Previous Version of OilExpress

Upgrading from OilExpress v3.x

If you are upgrading OilExpress from version 3.x, simply uninstall the previous version of OilExpress before installing the latest version.

All your OilExpress data is automatically retained.

Upgrading from earlier versions

If you are upgrading OilExpress from a version earlier than 3.0, and you want to retain the databases from the previous installation, you must copy some files from the old installation into the new installation.

NOTE: The security database cannot be retained. After completing the upgrade you must recreate all users.

1. Copy the files specified in the upgrade notes that follow this procedure.
2. Uninstall OilExpress.
3. If required, uninstall Spectrum, and then install the latest version.
   Follow any applicable guidance provided in the *Spectrum Administrator's Guide* (L1050095), which is provided on the *IR & Raman Manuals CD* (L1050002).
4. Log in to Spectrum and install the spectrometer.
5. Install the latest version of OilExpress (see *Installing the OilExpress Software* on page 54).
6. Restore any OilExpress database files you copied at step 1.

Upgrading from OilExpress v2.2

Before uninstalling OilExpress v2.2, make copies of these database files:

C:\Documents and Settings\All Users\Application Data\PerkinElmer\OilExpress\Local Repository*

C:\Documents and Settings\All Users\Application Data\PerkinElmer\OilExpress\Fuel Calibrations*

C:\Documents and settings\All users\Application Data\PerkinElmer\OilExpress\Local Resultstore\resultstore.mdb

(where * means copy the entire contents of the folder).

After uninstalling OilExpress v2.2, copy the contents of the **Local Repository** and **Fuel Calibrations** folders back to their original locations.

After installing the latest version of OilExpress (see *Installing the OilExpress Software* on page 54), migrate the **resultstore.mdb** file:

1. Start the Database Tools utility.
   Select **Start**, **All Programs**, **PerkinElmer**, **OilExpress** and then click **Database Tools**.
2. Select **Result Stores** and then click **Migrate Database**.
3. Open the **resultstore.mdb** file you copied from the previous installation.
4. Enter a short name and a file name for the migrated database.
5. Select the new database from the list and click **Set Active Database**.

Upgrading from OilExpress v1.0 or v2.0

NOTE: Make copies of these database files **before** uninstalling OilExpress.

- Copy the **batchstore.mdb**, **reference spectra.mdb** and **repository.mdb** files into folder C:\Documents and Settings\ All Users\Application Data\PerkinElmer\OilExpress \Local Repository.
- Copy the **resultstore.mdb** file into folder C:\Documents and Settings\ All Users\Application Data\PerkinElmer\OilExpress\Local Resultstore.
- Copy the fuel calibration files into folder C:\Documents and Settings\ All Users\Application Data\PerkinElmer\OilExpress\Fuel Calibrations.

For OilExpress version 1.0, these files can be found in:

C:\Program Files\PerkinElmer\OilExpress\Local Repository

C:\Program Files\PerkinElmer\OilExpress\FuelCalibrations

C:\Program Files\PerkinElmer\OilExpress\Local Resultstore.

After installing the latest version of OilExpress (see *Installing the OilExpress Software* on page 54), migrate the **resultstore.mdb** file:

1. Start the Database Tools utility.
   Select **Start**, **All Programs**, **PerkinElmer**, **OilExpress** and then click **Database Tools**.
2. Select **Result Stores** and then click **Migrate Database**.
3. Open the **resultstore.mdb** file you copied from the previous installation.
4. Enter a short name and a file name for the migrated database.
5. Select the new database from the list and click **Set Active Database**.

Installing the OilExpress Software

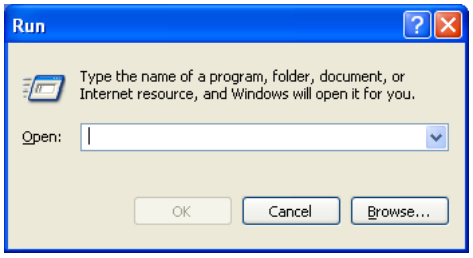
The Liquid AutoSampler software CD contains an Installation Wizard to help you install OilExpress on your PC.

NOTE: The Spectrum software must be installed *before* OilExpress. Consult the documentation supplied with your spectrometer, on the *IR & Raman Manuals CD* (L1050002) for details.

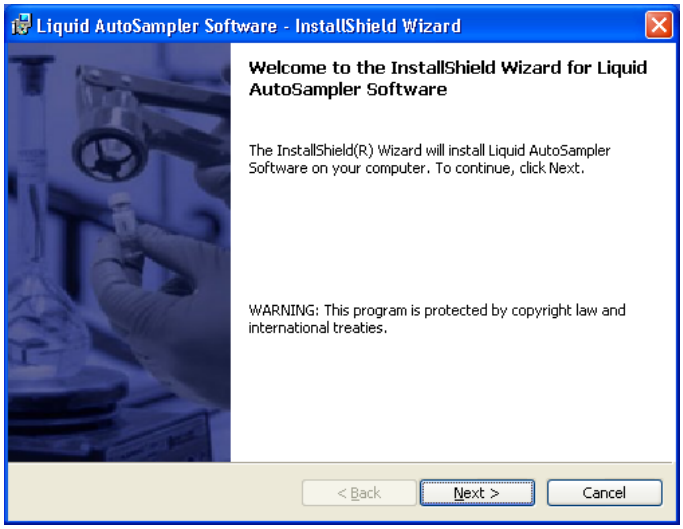
Once the Spectrum software has been installed, details of how to administer it can be found in the *Spectrum Administrator's Guide* (L1050095), which is also provided on the Manuals CD.

To install OilExpress:

1. Place your Liquid AutoSampler software CD into your CD-ROM drive.
2. If the CD does not auto-run, select **Run** from the Start menu.
   The Run dialog is displayed.

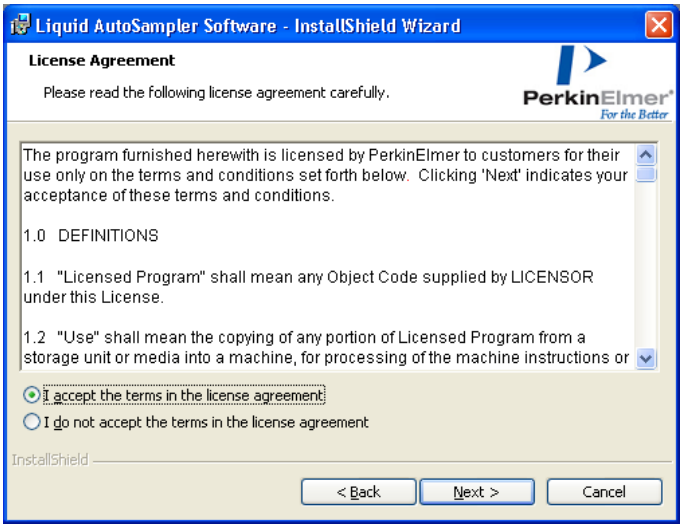


3. Enter **d:\Setup.exe** and click **OK**.
   Replace **d:** with the drive letter for your CD-ROM drive.
   After preparing to install, the InstallShield Wizard Welcome dialog is displayed.



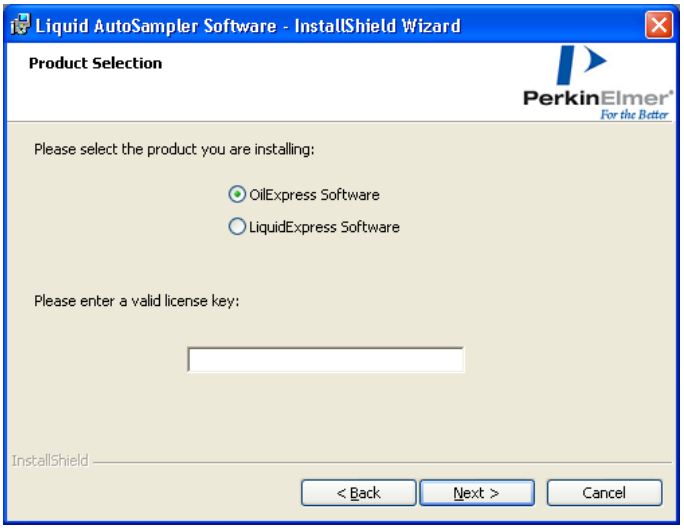
4. Click **Next**.

   The License Agreement dialog is displayed.

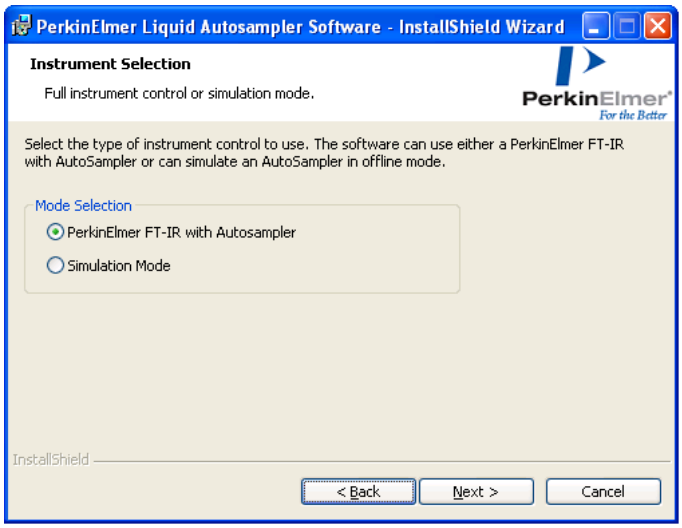


5. Read the agreement, select **I accept the terms in the license agreement**, and then click **Next**.

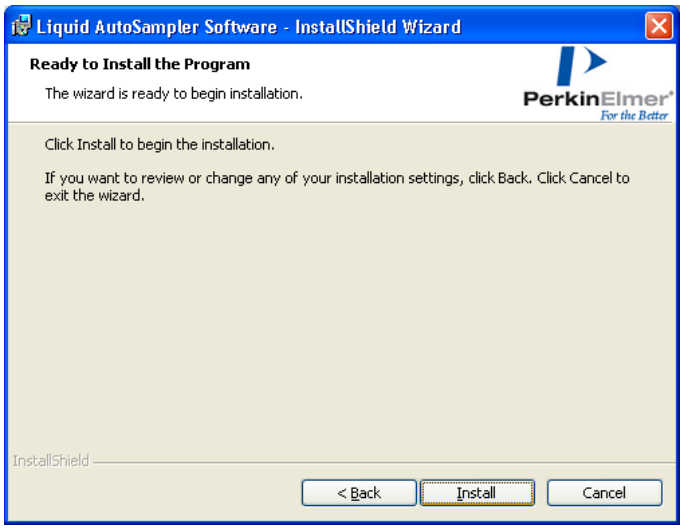
   The Product Selection dialog is displayed.



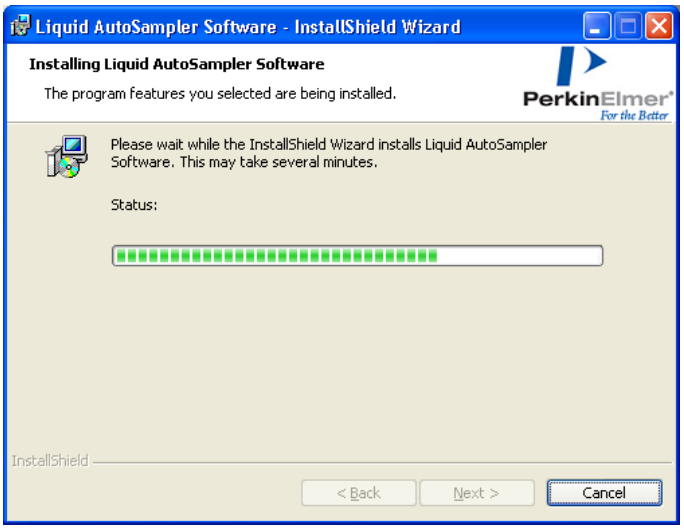
6. Select the **OilExpress** option and enter your license key; then click **Next**.
   The Instrument Selection dialog is displayed.



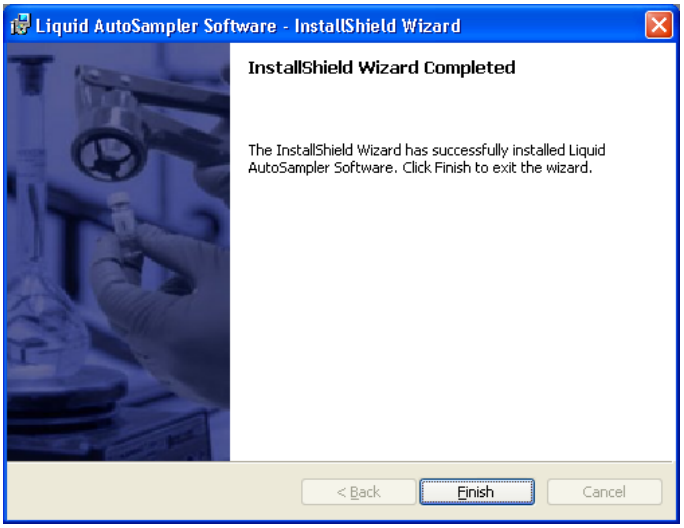
7. Select **PerkinElmer FT-IR with Autosampler** and click **Next**.
   Your software can now be installed.



8. Click **Install**.
   The installation will start.



When the installation is complete, the following dialog will be displayed:



9. Click **Finish**.

Default Users for OilExpress

The default passwords for the default user groups in OilExpress are the same as the name of the group, as follows:

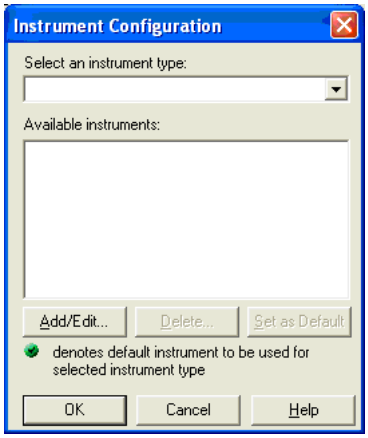
Login Name	Password
Administrator	administrator
Advanced Analyst	advanced analyst
Analyst	analyst
Supervisor	supervisor

You should immediately change these passwords to stop any unauthorized access to the software.

For further information see *Setup Users and Groups* in the on-screen Help.

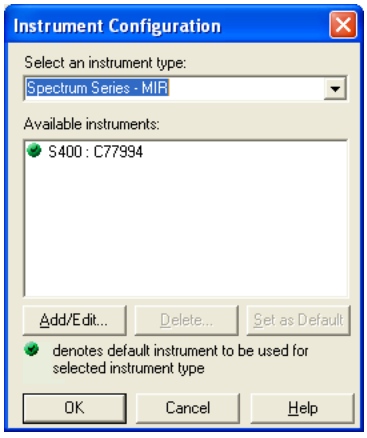
Starting up OilExpress and Configuring your Instrument

The first time you start the OilExpress system, if you have not already installed instruments using the Spectrum software, the Instrument Configuration dialog is displayed.



Use the **Add/Edit** button to add one or more instruments. See the on-screen help for details.

NOTE: Subsequently, if you want other instruments to be made available, you can use the menu option **System Settings > Instruments Settings > Configure Instrument.**



Click **OK**.

NOTE: If you make more than one instrument available for use with OilExpress, or a single instrument capable of operating in both near- and mid-infrared, you are prompted to select which instrument and mode is to be used each time you start OilExpress.

OilExpress should only be used with a spectrometer operating in mid-infrared.

Calibration

Before using the OilExpress System two calibration tasks must be performed:

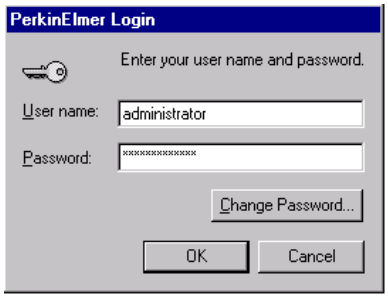
- Calibrate the Autosampler
- Calibrate the flowcell

Calibrating the Autosampler

The Autosampler must be calibrated to correct for any differences in the X-Y-Z zero alignment and any differences in the injection/wash port positioning.

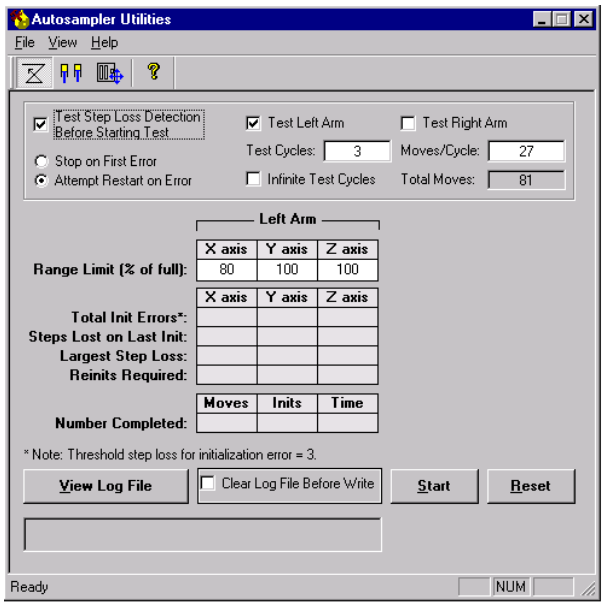
1. From the **Start** menu select: **Programs > PerkinElmer > Applications > OilExpress > Autosampler Utilities**.

   The login screen (PerkinElmer or Windows, as appropriate) is displayed.

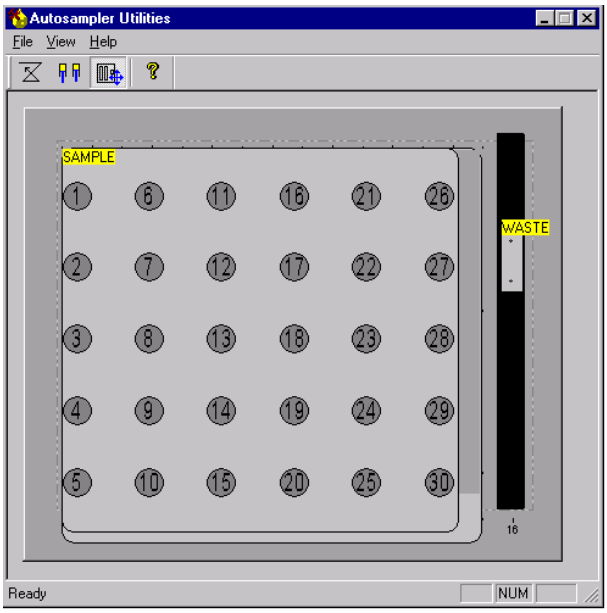


2. Enter a User name and Password.

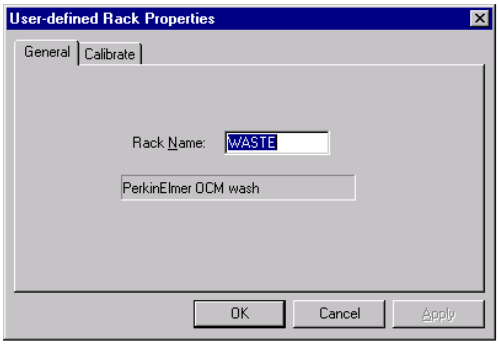
   The Autosampler Utilities dialog is displayed.



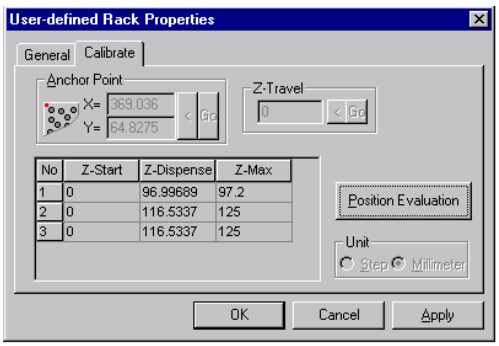
3. From the File menu select **WorkTable Editor**.
   The following dialog is displayed.



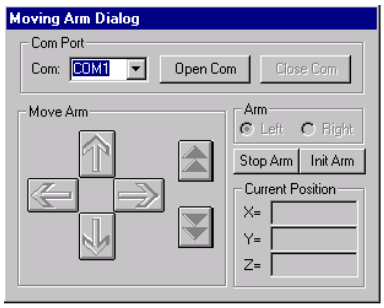
4. Right-mouse click on the **Waste Port**, and from the drop-down menu displayed select **Properties**.
   The following dialog is displayed.



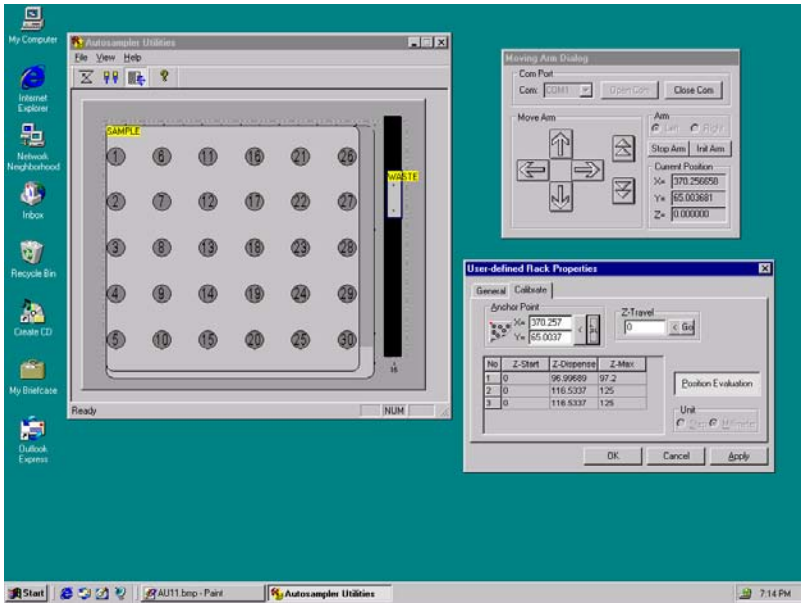
5. Select the **Calibrate** tab.



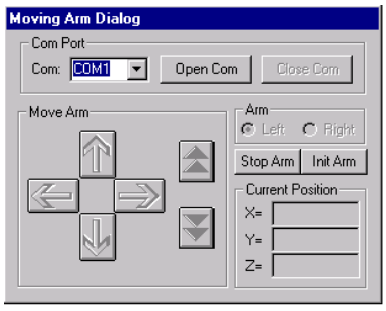
6. Click **Position Evaluation**.
   The following dialog is displayed.



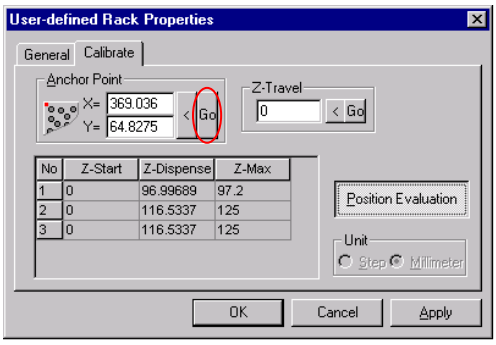
7. Separate the three dialogs on your desktop as shown below.



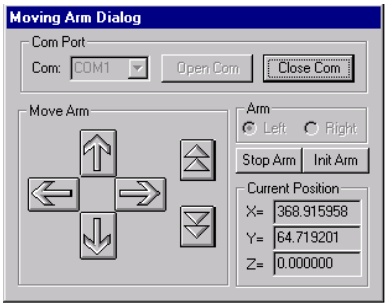
8. On the Moving Arm Dialog click **Open Com**.
   The Autosampler initializes.



9. In the Anchor Point section of the User-defined Rack Properties dialog, click **Go**.



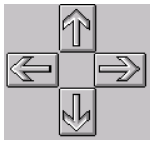
10. Click the down button  on the Moving Arm Dialog to lower the needle so that it is as close as possible to the top of the injection/wash port without actually touching it.



CAUTION

Do not constantly press  *as this will cause the needle to accelerate.*

Take care not to ram the needle into the injection/wash port as this may cause the needle to bend.

11. Use the left and right arrow buttons  to move the needle so that it is at the anchor point.

The anchor point depends on the version of your wash station. Examine the injection/wash port fitted, then use the appropriate needle position anchor point, as shown in Figure 25.

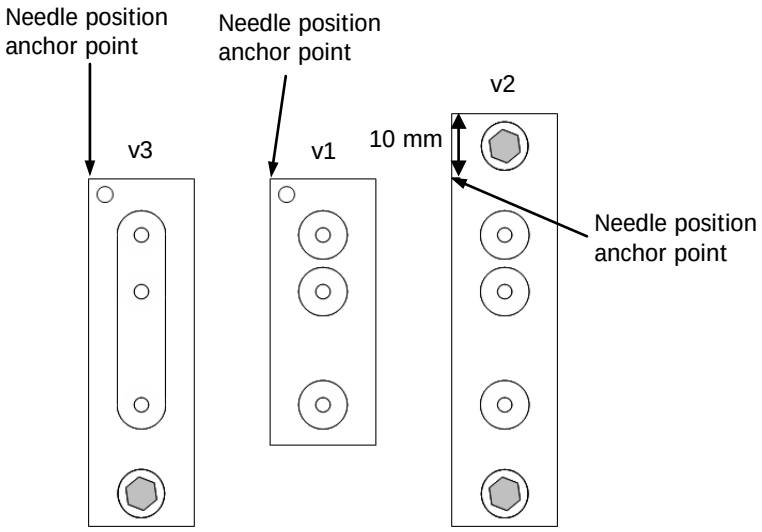
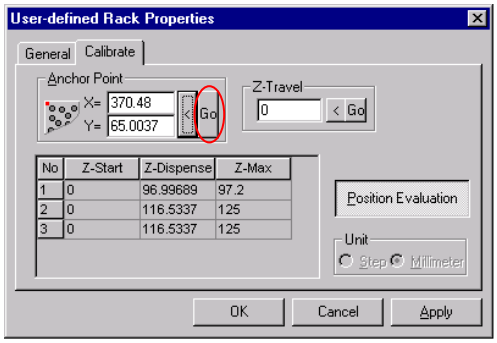


Figure 25 Injection wash port anchor positions

12. Once the needle has been aligned with the anchor point, click the Anchor Point Insert button  .



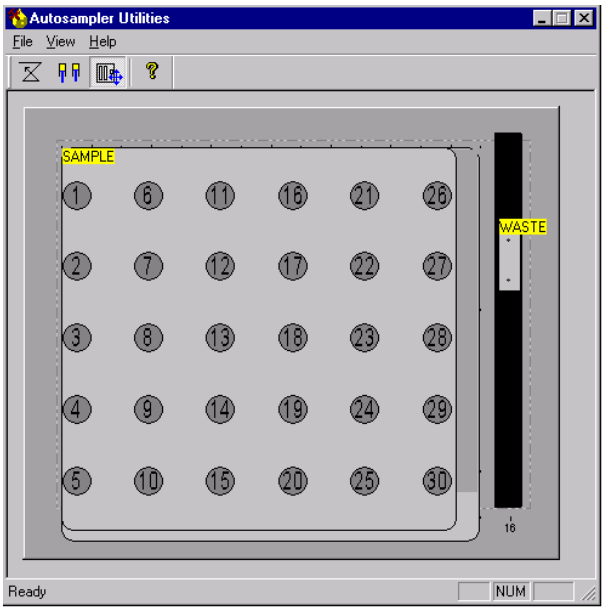
The new numbers appear in the **X=** and **Y=** fields.

13. Record the **Anchor Point X** and **Y** values in your laboratory notebook as the numbers can be used in the calibration of other worktables.

14. Click **OK**.

15. Right-mouse click within the worktable area of the Autosampler Utilities dialog and from the menu select **Save Worktable**.

NOTE: The worktable changes are not automatically saved. If you do not select **Save Worktable**, the changes will be lost.



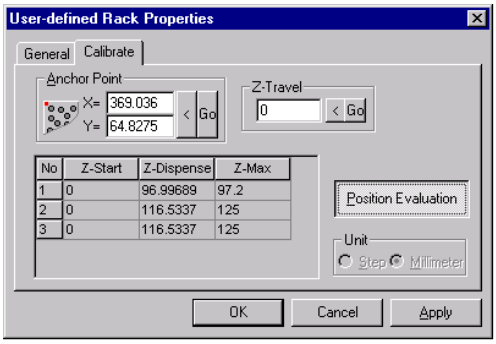
NOTE: The procedure described above must be repeated for all worktables used by the OilExpress software as anchor points are not applied universally. Follow steps 16 to 20 to calibrate all additional worktables.

16. Right-mouse click within the worktable area of the Autosampler Utilities dialog and from the menu select **Load Existing Worktable**.

17. Select the required worktable, **PerkinElmer BOTTLES** or **PerkinElmer VIALS**.

18. Repeat steps 4 to 7.

19. Enter the values you previously recorded in your laboratory notebook into the **X=** and **Y=** fields of the User-defined Rack Properties dialog.



20. Repeat steps 14 and 15.

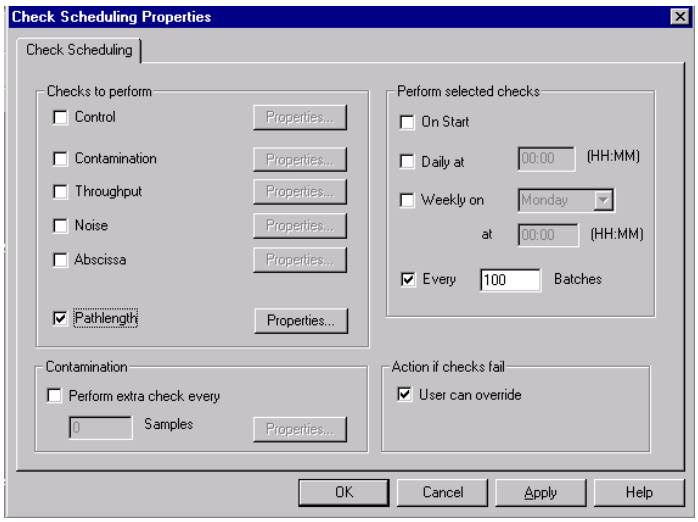
21. If the syringes have not yet been installed, complete the hardware installation on page 50.

Calibrating the Pathlength of the Flowcell

The OilExpress software calculates the cell pathlength by using a Partial Least Squares multi-component calibration on heptane. A default calibration file is provided and stored as c:\quant\pls1\methods\cellpath.md, where c:\ is the drive to which the OilExpress software has been installed. Heptane must be used as the solvent within the OilExpress System for accurate cell calibration.

1. Log in to OilExpress.

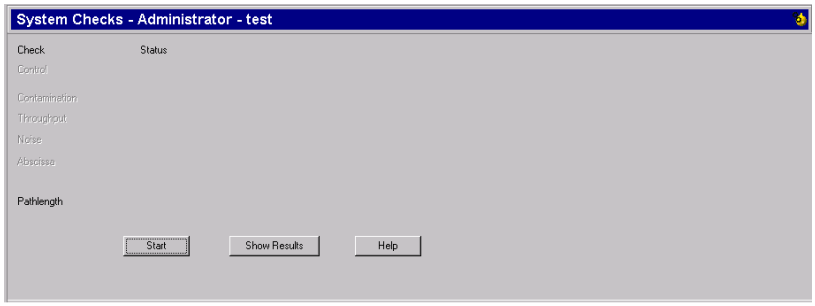
2. Select **System Settings > Instrument Settings > System Checks Setup**.
   The **Check Scheduling Properties** dialog is displayed.



3. Select **Pathlength** and click **OK**.

4. Click the System Checks thumbnail 

on the left-hand panel in the main OilExpress dialog.
   The System Checks dialog is displayed.



5. Click **Start**.

   The Autosampler pumps are primed when the system is initialized to ensure that the cell is filled with heptane. (To prime the pumps manually, refer to *Autosampler Control* in the online help). The check will be performed.

NOTE: If additional system checks are selected, these will be performed in addition to the pathlength check in the order that they appear on the screen.

On completion of the pathlength check, **Passed** or **Failed** will appear in the dialog. If the pathlength falls between the limits expected for the ZnSe cell, then the pathlength will be automatically stored for future use in OilExpress analyses.

If the pathlength check fails, checks the following and then repeat the steps described above:

- The correct solvent was used
- The solvent was delivered to the cell correctly and there were no leaks
- The beam of the spectrometer is not obstructed
- The cell is in the correct position within the sample shuttle
- The limits within the pathlength setup are correct

Installing the Arm Shield

1. Remove the clear rectangular arm shield from the accessory box.
2. Remove the three screws (Figure 26).
3. Position the arm shield under the arm and adjust the shield so that the holes in the shield are aligned with the screw holes on the side of the arm cover.

4. Insert the socket head screws through the holes and tighten by turning the screw clockwise.

CAUTION *Do not over tighten the screws as this may crack the plastic shield.*

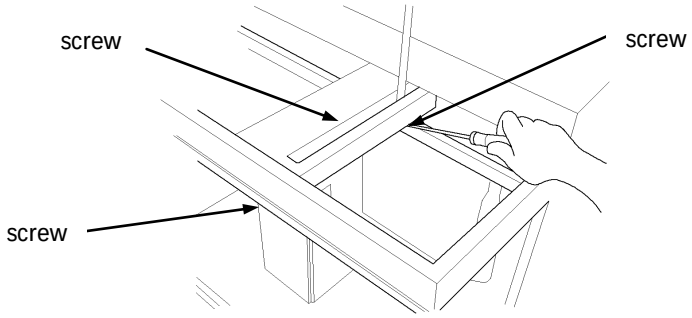


Figure 26 Installing the arm shield

Background to Used Oil Analysis

Background to Used Oil Analysis

Infrared Absorption

The chemical bonds within organic molecules are in a state of continual vibration, with bonds stretching and contracting as well as bending relative to each other. When an infrared beam falls on a molecule, waves of specific frequencies are absorbed from the beam by the molecule. The actual frequencies absorbed depend on the types of bonds present in the molecule structure. Chemical bonds within a molecule are said to exhibit “characteristic infrared absorptions”.

A record of the frequencies at which absorption takes place for an organic compound is called its infrared spectrum. An infrared spectrum of a compound will reveal information about molecular structure as the existence of specific groups of atoms may be confirmed from the presence of their characteristic absorptions.

Why Analyze Used Oils?

Infrared analysis of used oils provides critical information regarding the state of the lubricant itself and the engine from which it comes.

Used oil analysis provides a great deal of information in two areas:

1. The physical condition of the lubricating oil, such as its viscosity, neutralization number, or level of contamination.

2. The condition of the component or system from which the sample was taken.

The presence of chemical degradation products due to oxidation, nitration, sulfate formation, ester breakdown, and anti-wear additive depletion, and contaminants such as soot, water, ethylene glycol and unburned fuel is used to measure the degradation of the oil.

Analyzing used oil samples and comparing the resulting spectrum (showing characteristic absorptions of the degradation products, oil and contaminants) with an unused oil spectrum contained in a “new oil” library accurately monitors the chemical degradation of engine lubricants.

Methods of Analysis

The OilExpress System is an automated system that uses infrared (IR) analysis to monitor oil quality parameters: chemical degradation products and common contaminants of lubricating oils. The OilExpress System provides a range of Analysis Methods for measuring these parameters, including standard methods for Mineral Oils, Synthetic Oils, and the Joint Oil Analysis Program (JOAP). Within OilExpress, methods can be added or deleted, and the properties of existing methods customized.

Used oil samples are complex mixtures of a large number of different chemicals and include compounds derived from the original formulation of base oil and its additives, oil degradation products and oil contaminants. As a result of this a used oil spectrum is complex; because of this complexity, the spectrum of a used oil alone is of limited value and must be compared against a spectrum of the unused oil to be of any significant analytical value.

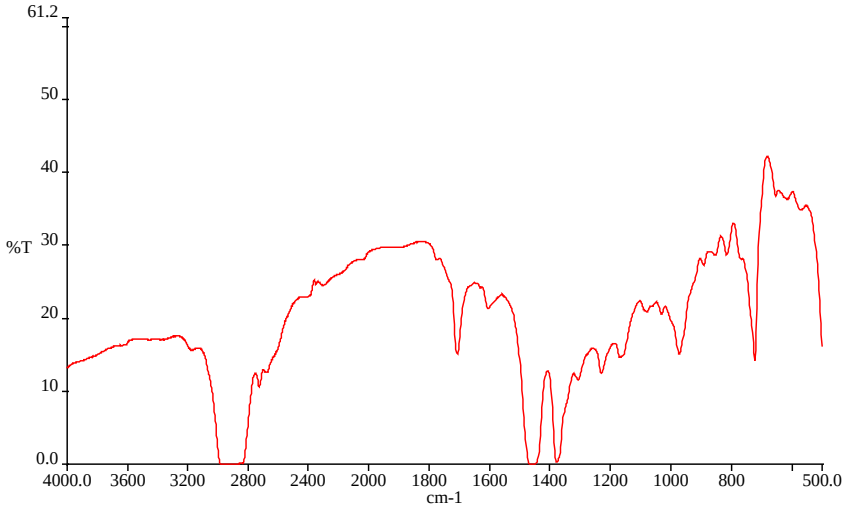


Figure 27 Spectrum of a used oil sample

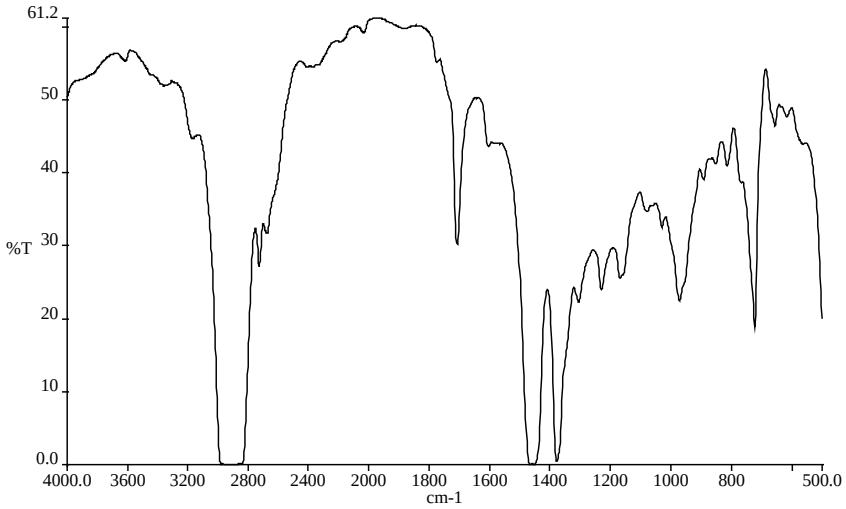


Figure 28 Spectrum of an unused oil sample

Figure 27 and Figure 28 illustrate the comparison of a used oil sample and a sample of the same oil unused. From these spectra it would be fair to assume that minimal degradation has occurred.

This situation changes dramatically when a differential spectrum is viewed.

Figure 29 shows the baseline corrected difference spectrum of the same two samples, obtained by subtracting one spectrum from the other and then performing a baseline correction.

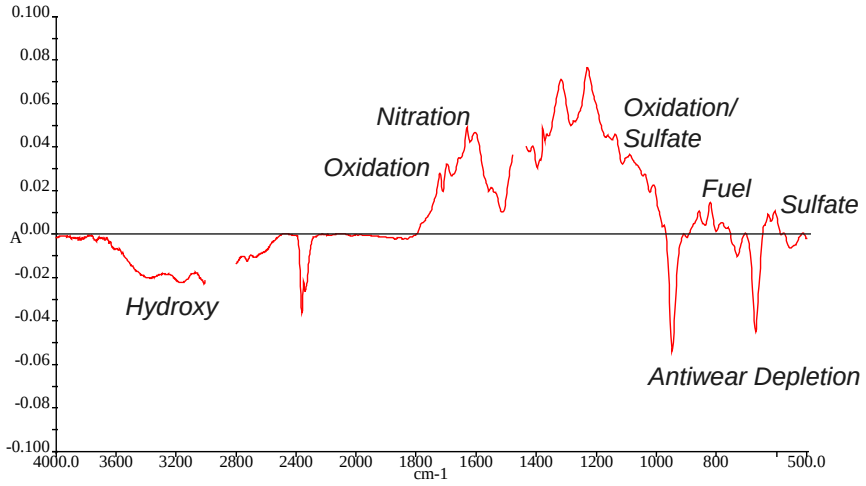


Figure 29 Baseline corrected difference spectrum

This data can now be manipulated mathematically to provide information about the differences between the new and used oil, and may be considered to be a spectrum of the degradation products that exist in the used oil.

In both cases, the trends observed in the results from a series of samples taken at regular time intervals from the same engine have a much higher diagnostic value than the results from a lone sample.

Degradation Products

Oxidation

Oil exposed to oxygen from the air at elevated temperature will oxidize to a variety of compounds, the majority of which are carbonyl compounds, including carboxylic acids. Carboxylic acids contribute to the acidity of the oil, depleting the basic additives present in the oil and contributing to corrosion. Oxidation can also increase the viscosity of the oil. The degree of oxidation is a good indicator of oil degradation. A rapid increase in oxidation may indicate an engine overheating or a depletion of the anti-oxidant additive due to an over-extended oil change period.

Nitration

Nitrogen oxides, produced from the oxidation of atmospheric nitrogen during the combustion process, react with the oil. Nitration increases the viscosity of the oil and is the major cause of the build-up of varnish or lacquer.

A high nitration value, also known as NO_X or nitro-oxidation, indicates incorrect fuel/air ratio, incorrect spark timing, excessive loads, low operating temperature or piston ring blow-by.

Sulfate

Sulfur oxides are produced by the combustion of sulfur compounds present in the fuel. These oxides react with water, also produced by the combustion process, to form sulfuric acid. The sulfuric acid is neutralized by the oil's basic additives, forming inorganic sulfates. A rapid increase in the sulfate value may indicate the use of a high sulfur content fuel, poor combustion, over-cooling or the rapid depletion of anti-wear additive.

Ester breakdown

Synthetic lubrication oils usually contain a high proportion of synthetic polyol esters. These esters are susceptible to breakdown in the presence of water and acids (hydrolysis). Ester breakdown contributes to the acidity of the oil and can result in the formation of crystals of the base polyol, leading to clogging of filters. Ester breakdown may indicate the presence of water from condensation caused by low operation temperatures or from a coolant leak.

Common Contaminants

Soot

Soot particles result from the incomplete combustion of fuel and, since they are too small to be removed by the filter, remain suspended in the oil. Soot builds up continuously until it reaches an unacceptable level, that level depends on the type of engine and lubricant. Diesel oils tolerate higher soot levels than gasoline oils. The rate of soot build up depends on engine design, type of fuel and operating conditions. A high soot value may indicate poor combustion due to incorrect fuel/air ratio, a clogged air filter or an over-extended oil change period.

Water and glycol

The presence of water and glycol indicate a leak from the cooling system. It is essential to detect such a problem early to avoid a serious failure. The presence of water alone does not necessarily indicate a coolant problem, but may result from condensation due to a low operating temperature.

Unburned fuel

The fuel measurement depends not only on the level of contamination, but also on the aromatic hydrocarbon content of the fuel. The amount of aromatic content in fuels vary in location and season, therefore a calibration must be done on the fuel being used. The presence of fuel indicates poor combustion due to incorrect fuel/air ratio, clogged air filter or an ignition problem. It may also indicate an over-extended oil change period.

Analysis Methods

The OilExpress System ships with a set of default analysis methods that will appear in the drop-down menu. The methods vary in the analytes they determine, the peaks used and the warning limits on the results. For further information about the default analysis methods see the on-screen Help.

Sample Preparation

Filtering the Oil

It is important that all oil samples are filtered to prevent large particles blocking the flowcell, however, care should be taken not to remove any soot particles. A steel mesh filter (90 microns) is recommended.

Sample Presentation Requirements

Carefully record details of the oil contained in each bottle. Place the sample bottles in the sample rack, ensuring that the lids have been removed.

The OilExpress System bottle rack accepts standard 4 oz oil sampling bottles. If a smaller diameter bottle is used ensure that it is centered in the sample holder.

NOTE: For information on how to use the OilExpress System, see the help system available from the Help menu in the OilExpress software, which includes a tutorial and full information on using the software.

Routine Maintenance and Troubleshooting

Maintenance Schedule

Maintenance must be performed on a regular basis in order to maintain the accuracy and precision of the OilExpress System. The schedule below outlines the proper intervals to check or replace components of the instrument.

NOTE: For information on maintaining your spectrometer, refer to the documentation supplied with the instrument.

Item	Daily	Weekly	6 Months
ALIDUM Cable	-	X (p.79)	R (p.82)
Sampling Probe	C/X (p.77)	C/X (p.77)	R (p.80)
Z-Rack	-	C (p.77)	-
Splash Guard	-	C (p.78)	-
Transfer/Wash Port	-	C (p.77)	-
Syringe	C (p.77)	C (p.77)	S (p.80)
Syringe Seal	C (p.77)	-	R (p.80)
Sample Rack	C (p.77)		
Sampling Probe	C (p.77)	-	R (p.79)
X/Y/Z Mechanism	-	-	X (p.78)
X/Y/Z Lubrication	-	-	S (p.84)
Tubing	-	-	S (p.85)

Key:

C = Clean this item
R = Replace component
X = Perform service
- = No action necessary
S = Special case

Autosampler Maintenance Procedures

Flushing the Syringe Pump

1. Do not allow the pump to run dry for more than a few cycles.
2. Inspect the pump for leaks, and correct any problems immediately.
3. Wipe up all spills on and around the pump immediately.

Cleaning the Syringe Seal

1. Clean the seal with heptane.
2. Check for cracks in the Teflon coating.

Cleaning the Sampling Probe

CAUTION *Electrostatic discharge to the sampling probe may damage the ALIDUM.*

1. Turn off power to the Autosampler.
2. Clean the needle by wiping gently with a lint-free cloth dampened with heptane.

Cleaning the Sample Rack

We recommend that you clean the sample rack daily with detergent or degreasant to remove dust and oil.

Cleaning the Injection and Wash Port

Residues from samples may be deposited in the injection/wash-port. We recommend that you remove the lid occasionally and rinse it with a suitable detergent if necessary.

Cleaning the Z-Rack

The Z-Rack must be cleaned weekly.

NOTE: Do not use alcohol or solvents when cleaning the Z-Rack.

1. Turn off the power to the Autosampler.
2. With a lint-free cloth, wipe the Z-Rack thoroughly.
   If necessary, use a toothbrush to remove dust or dirt from the teeth of the Z-Rack.

Cleaning the Splash Guard/Safety Shields

The Splash Guard/Safety Shields must be cleaned weekly.

1. Turn off the power to the Autosampler.
2. With a lint-free cloth, wipe the splashguards thoroughly.

Cleaning the Lead Screw and Lead Screw Encoder

If the pump is used in a dusty environment, the lead screw encoder should be cleaned periodically with air. The lead screw should be lubricated:

- If the pump is making a "screeching" noise
- If the syringe is stalling frequently

NOTE: Only PerkinElmer lubricant (part number L1200559) should be used for lubricating the lead screw. Lubrication is usually only needed after 1 million syringe strokes (or every 6 months). If the pump appears to need lubrication more frequently, suspect another problem.

Cleaning X-Y-Z Mechanism

The X-Y-Z mechanism should be cleaned every six months. However, if the instrument is operated in a dusty or humid environment, it must be cleaned every three months. Follow the instructions to prevent damage to the instrument.

CAUTION	*Use only isopropyl alcohol and a lint-free cloth to clean the Autosampler. Other cleaning agents may affect the performance of the instrument. Never clean the X-Y-Z axis guide rails or Z-Rack with alcohol or solvent. Serious damage to the instrument may occur.*

1. Turn off the power to the Autosampler.
2. Clean the Z-Rack.
3. Clean the needle.
4. Wipe the arm using a lint-free cloth dampened with isopropyl alcohol to remove any residual dust.
5. Wipe the inside of the flex cable channel using a lint-free cloth dampened with isopropyl alcohol.

CAUTION	*Do not wipe the X-axis guide rails. The guide rails are lubricated with a grease that does not require removal unless found to be "extremely" dirty.*

6. Wipe the inside of the X-frame with a lint-free cloth dampened with isopropyl alcohol, ensuring that the lubricant on the X-axis guide rails is not removed.

7. Wipe the square shaft pinion located underneath the arm using a lint-free cloth dampened with isopropyl alcohol.

CAUTION *When cleaning the square shaft pinion, ensure no alcohol enters the Z-bearing or is wiped on the Y-axis guide rails.*

Inspecting the Insulation Block/ALIDUM Cable Assembly

The insulation block/cable assembly must be inspected weekly and replaced every six months. Examine the cable where it connects to the insulation block. If there is any residue, liquid, or if the cable is cracked at this connection, replace the assembly.

NOTE: Instructions on how to replace the insulation block cable can be found in *Replacing the Insulation Block/ALIDUM Cable Assembly* on page 82.

Checking the Fluid Path (Tubing)

Check that all the tubing is clean and free of crimps. Refer to *Replacing the Tubing* on page 85 for procedures to change tubing.

Replacing the Sample Probe/Needle

1. Turn the power off to the Autosampler.

2. Loosen the sampling probe set screw using a flat screwdriver.

3. Loosen the insulation block set screw using an Allen wrench.

4. Gently pull downward on the insulation block until the system tubing is approximately 1 inch below the Z-Rack.

CAUTION *Electrostatic discharge to the needle may damage the ALIDUM detector.*

5. While holding the needle, remove the system tubing.

6. Remove the needle from the bottom of the insulation block.

7. To reinstall the needle, refer to *Sampling Probe/Needle* on page 15.

NOTE: If the needle has been bent, it should be replaced.

Replacing the Syringe Seal

The syringe seal will need to be replaced periodically. How often will depend on the duty cycle of the pump, the type of fluids being run through the system, the size of the syringe and how well the instrument is maintained. If the syringe seal becomes worn and is not replaced, the following problems may occur:

- Poor precision and accuracy.
- Variable or moving air gaps.
- Fluid leaks from the bottom of the syringe.
- The tip of the plunger breaks through the seal and scratches the inside of the syringe barrel. If this happens, the entire syringe will need to be replaced.

Replacing a Syringe

1. Refer to *Installing the Syringe* on page 50.
2. Remove the plunger pin at the base of the syringe plunger.
3. Release the syringe clamp and carefully unscrew the syringe barrel from the Luer lock fitting (about 1½ turns) while pulling downward slightly. Then slide the syringe plunger from the plunger shaft.
4. To install a syringe, place the plunger over the plunger shaft. Line up the barrel with the Luer lock fitting. Screw the barrel onto the fitting while pushing upward slightly.

CAUTION	*You must assist the Luer lock threads by pushing upward, otherwise they may become stripped.*

5. Replace the plunger screw at the base of the syringe plunger.

Replacing the Reagent Syringe Seal

1. Refer to *Installing the Syringe* on page 50.
2. Remove the plunger pin at the base of the syringe plunger.
3. Release the syringe clamp and carefully unscrew the syringe barrel from the Luer lock fitting (about 1½ turns) while pulling downward slightly. Then slide the syringe plunger from the plunger shaft.
4. Remove the syringe plunger.

5. Remove the seal from the plunger tip using a pair of pliers and gripping the seal approximately one third of the way down (Figure 30).

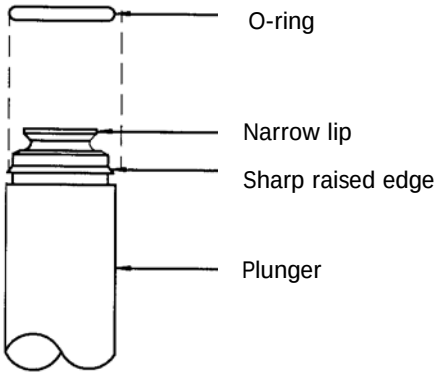


Figure 30 Plunger and O-ring configuration

CAUTION	*The 10.0 ml syringe has an O-ring beneath the seal. Be careful not to damage the O-ring. If it is necessary to replace the O-ring, simply slip the new one over the narrow lip on the plunger. It may be necessary to use needle nose pliers to assist in removing the O-ring from the plunger.*

6. Wet the plunger tip and the O-ring with distilled or de-ionized water.

7. Place the seal on a flat surface with the open end facing up. Press the plunger tip firmly into the hole until it snaps into position.

8. Lay the plunger on a flat tabletop. Position the plunger so that the seal (from the O-ring up) hangs over the edge (Figure 31). Slowly roll the plunger along the table edge, pressing firmly on the portion of the seal below the O-ring. Rotate the plunger three complete turns. This is necessary for the sharp, raised edge of the plunger to bite into the seal for a secure fit.

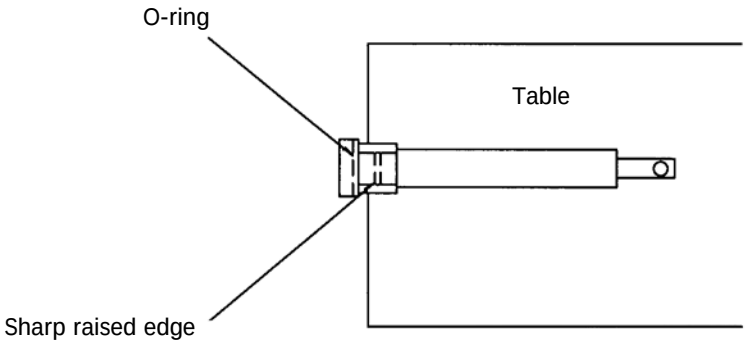


Figure 31 Seal installation

9. Wet the seal and replace the plunger in the barrel.

10. Replace the syringe.

Replacing the 3-port Valve

1. Remove the syringe as described in *Replacing a Syringe* on page 80.
2. Power down the Analyzer.
3. Remove the aspirate tubing, reagent tubing and syringe.
4. Remove the valve by loosening the two screws on the valve.
5. Install the new valve by aligning the "D" coupler on the valve stem with the "D" hole in the encoder.
6. Rotate the valve body so that the Luer fitting is oriented toward the bottom of the pump.
7. Gently push the valve in place ensuring the locating pins on the frame side of the valve body fit in the holes on the XL 3000 frame and replace the screws.
8. Replace the syringe.
9. Power up the Autosampler.

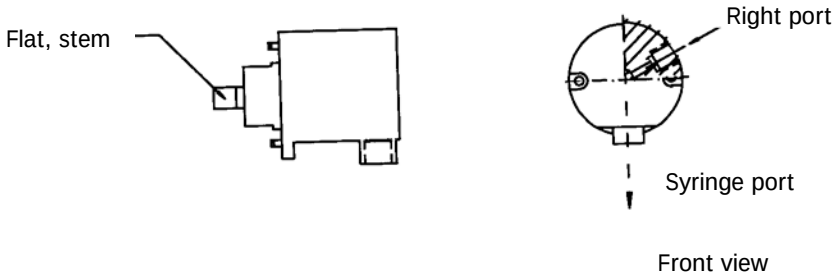


Figure 32 CAVRO 3-port valve

Replacing the Insulation Block/ALIDUM Cable Assembly

1. Turn off the power to the Autosampler.
2. Remove two (2) screws on the back of the top cover.
3. Remove the top cover of the instrument by lifting both sides.
4. Remove the sampling probe.
5. Remove the plastic cable strap underneath the arm, which is holding the insulation block cable.

NOTE: Use a small wire cutter to remove the plastic cable binder. A new cable binder is included with each spare replacement insulation block.

6. Push the insulation block cable through the back end of the arm until the gold connector is visible.

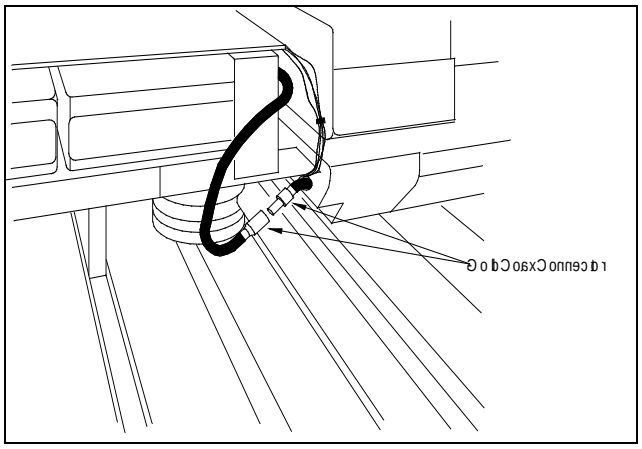


Figure 33 Disconnecting the insulation block cable

7. Disconnect the insulation block cable from the connector.
8. Carefully pull the insulation block cable back out through the back of the arm.
9. Remove the new insulation block cable and the plastic cable strap from the packaging.
10. Feed the gold connector of the insulation block cable through the back of the arm.
11. Attach the gold connector to the matching connector on the ALIDUM cable. Be sure that the connectors are firmly seated.
12. Adjust the ALIDUM cable until all of the slack is removed from behind the arm.

CAUTION

Make sure the insulation block cable is not twisted or kinked.

13. Fasten the insulation block cable to the arm using the new plastic cable binder.
14. Reinstall the sampling probe.
15. Replace the top cover and retaining screws.

Lubrication

The Autosampler does not require lubrication under normal operating conditions. If the lubricant applied at the factory should be wiped away or if the X/Y axis guide rails become dirty, cleaning and lubrication is necessary. Follow the instructions below when applying lubricants.

1. Turn off the power to the Autosampler.
2. Move the arm to the far right side of the X-frame.
3. Clean the X-axis guide rails using a lint-free cloth and isopropyl alcohol.
4. While moving the arm to the left side of the X-frame, clean the three roller bearings mounted to the base of the X-slide.
5. Wipe the section of the X-axis guide rail that was covered by the arm.
6. Using a fingertip, apply a thin film of lubricant to both X-axis guide rails.
7. If the Y-axis guide rails are dirty, follow steps 2 through 6.

Changing the Autosampler Fuses

Two 5A fuses are fitted to the Autosampler.

1. Switch off the Autosampler and disconnect the mains electrical supply.
2. Disconnect the mains electrical supply lead from the side of the Autosampler.
3. Insert a small screwdriver into the slot above the fuse drawer and lever the fuse drawer out.
4. Remove both fuses from the fuse drawer.

NOTE: If a fuse blows, it is recommended that both fuses be replaced.

5. Fit the replacement fuses.
6. Push the fuse drawer back into the Autosampler, and switch on the Autosampler.

WARNING

For continued protection against risk of fire, only replace fuses which meet the following specified types and current rating.

The following fuse must be used when operating the Autosampler:

Name	Location	Type
Main Fuse	Power Entry Module	T5.0 A/250 V × 2

Replacing the Tubing

It is important that all tubing is kept clean and free of crimps. Tubing that has become dirty, blocked or crimped can result in poor accuracy and precision, loss of air gap, or syringe stalls. Replace the tubing if necessary. Frequency of replacement will be dependent on duty cycle, reagents and maintenance.

WARNING

Switch off the Autosampler before replacing any tubing.

Replacing Reagent and Needle or Cell Tubing

Removing the old reagent tubing

1. Unscrew the connector from the right hand side of the valve (reagent tubing).
2. Pull the tubing clear of the Autosampler.

Installing the new reagent tubing

1. Route the end of the tubing with the fitting through the black grommet hole on the right panel.
2. Install fitting on the right valve port of the syringe pump.
3. Finger-tighten the fitting.

Removing the old needle tubing

1. Unscrew the connector from the left hand side of the left hand syringe pump.
2. Remove the insulation block from the Z-drive.
3. Pull the tubing from the needle end.
4. Withdraw the tubing from the Z-drive and tubing support.

Installing the new needle tubing

1. Route the end of the tubing with the fitting through the black grommet hole on the right panel.
2. Install the end of the tubing with the fitting into the left valve port of the left syringe pump.
3. Route the other end of the tubing through the tubing support and down the Z-drive.
4. Push the end of the tubing over the end of the needle and replace the insulating block onto the Z-drive.

Replacing Waste Tubing

Removing the old waste tubing

CAUTION	*Before removing the waste tubing, be sure the fluidic system/wash station is dry.*

- Disconnect the waste tubing from the wash station and remove the tubing from the Autosampler.

Installing the new waste tubing

1. Attach the waste tubing to the hose connector at the rear of the transfer/wash port.
2. Insert the waste tubing into the hole on the rear right-hand side of the base plate of the Autosampler.
3. Adjust the routing of the tubing so that it is not kinked.
4. Place the other end of the waste tubing in the waste container.
   Ensure that the end will not be immersed in the waste.

Maintenance of the Flowcell

In normal use of the OilExpress System, the cleaning utilities provided by the software ensure that the flowcell is routinely kept clean and free of contaminants.

If, however, the flowcell does become contaminated, it may be carefully dismantled for deep cleaning using lens tissues and heptane, then re-assembled. Contamination of the flowcell may be detected during calibration (see *Troubleshooting* on page 93).

Routine Cleaning of the Flowcell, Using Software Utilities

The procedure described below may provide an effective method for the routine cleaning of your flowcell without the need to disassemble it.

The frequency with which you need to carry out routine cleaning will depend upon the number and nature of the samples you work with. In particular, if you work with dirty or sooty samples, you may find that you need to clean your flowcell more frequently than will otherwise be the case.

1. With heptane in the solvent bottle, select **Autosampler Control** from the View menu and then click **Wash**.

2. Repeat the heptane wash 10 times.

3. Place a mixture of toluene with 10% isopropyl alcohol in a sample bottle, then select **Autosampler Control** from the View menu and use the **Aspirate** function.

4. Aspirate the solution into the cell, allow it to settle for a few seconds, and then wash it out with heptane, using the **Wash** function.

5. Repeat steps 3 and 4 a total of 10 times, then allow the solution to settle in the cell for 30 minutes before washing it out.

6. Repeat steps 3 and 4 a further 10 times.

7. Carry out 15 heptane washes.

8. Disconnect the tubing from the flowcell and dry it, either with air or by attaching it to a vacuum pump.

9. Finally, carry out a Throughput check using **System Settings > Instrument Settings > System Checks Setup**.

Deep Cleaning the Flowcell, Involving Disassembly

WARNING

Wear gloves when dismantling the cell as the zinc selenide (ZnSe) windows are toxic.

NOTE: A torque driver with a range of at least 10 – 25 cNm and a 3 mm hexagonal bit, for example part numbers L9003631 and L9003632, must be used to reassemble the flow cell. It is not recommended to start disassembling unless you have such a torque driver to-hand.

1. Using a 3 mm hexagonal wrench, undo and remove the three hexagonal screws.
2. Remove the parts of the flowcell in the following order:
   - The front of the cell
   - The PTFE gasket
   - The front window
   - The PTFE spacer
   - The former
   - The back window (this window has no holes in it)
   - The neoprene gasket

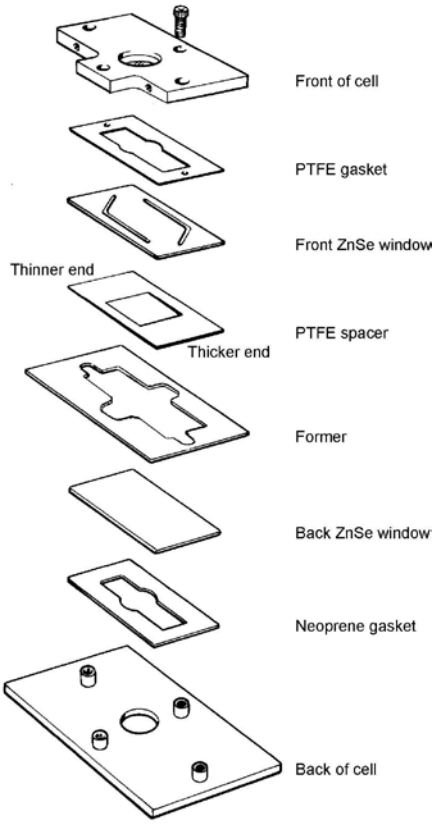


Figure 34 Dismantling or assembling the flowcell

3. When the flowcell is dismantled, use a lens tissue and a suitable solvent, for example heptane, to clean the flowcell.

WARNING

Do not use acid to clean the windows, as toxic fumes will be given off.

Take care not to crease the wedged PTFE spacer during cleaning as this may reduce its effectiveness at suppressing interference fringes, and may also alter the pathlength.

4. Refit the parts of the cell in the following order:
   - The neoprene gasket
   - The back window
   - The former
   - The PTFE spacer (with the thin edge of the wedge towards the top of the cell)
   - The front window
   - The PTFE gasket
5. Align the two holes in the PTFE gasket with the two holes at the ends of the channels in the front window.

6. Lay the front of the cell on top of the gasket.

7. Align the hole in the front of the cell with the holes in the gasket and front window.

CAUTION	*The windows in the flowcell are brittle and easily broken. Be careful that you do not tighten the screws holding the flowcell together too tightly.*

8. Insert and tighten the four screws using a hexagonal wrench until the screws just touch the front of the cell.

9. Use a torque driver to tighten the screws, in the sequence shown, until a torque value of 10 cNm is reached.

NOTE: The sequence in which you tighten the screws is important. The sequence shown below is designed to prevent unequal pressure being applied to the flowcell, and thereby help prevent any damage being caused.

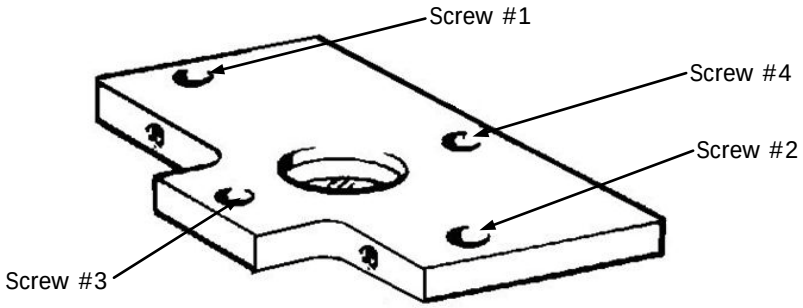


Figure 35 Flowcell securing sequence

10. Repeat step 9 until a torque value of 16 cNm is reached; and then again, until you reach a final torque value of 24 cNm.

11. Recalibrate the flowcell pathlength after dismantling and reassembling it.

NOTE: It is essential that the pathlength of the flowcell is recalculated after the cell has been dismantled. Failing to carry out this procedure will seriously affect the results obtained using the OilExpress System.

Warranty Exclusions and Limitations

The following consumable items are excluded from the warranty agreement. See *Spares and Consumables* on page 92 for details of part numbers and suppliers.

- Flowcell Windows
- Tubing
- Fuses
- Syringes
- Syringe piston noses

WARNING

Any attempts to perform installation or maintenance operations that are not detailed in this manual are at the user's own risk.

If a user-attempted service results in a visit by a PerkinElmer Service Engineer, the visit will not be covered by the instrument warranty.

Damage caused by the following is not covered by the warranty:

- Not maintaining the solvent level.
- Failure to flush the system adequately after use.
- Blockage of tubing, the transfer/wash port, needle or flowcell.
- Failure to observe the precautions described in this manual.

Spares and Consumables

Item	PerkinElmer Part Number
Matched pair of ZnSe Windows for flowcell	L1191081
Replacement Gasket and Spacer Set for flowcell	L1191082
Sample Rack (4 oz)	L1200551
Syringe (10 ml)	L1200552
Seal Kit (10 ml) for syringe plunger	L1200553
Valve 3-port	L1200554
Needle	L1200555
Pump to Solvent Tubing (2)	L1200556
Injection/Wash Port to Cell Tube	L1200557
Lubrication Kit	L1200559
Waste Tubing	L1200560
Plunger Screw	L1200571
Syringe Clamp	L1200574
RS232 Cable	L1200576
Wash Station Mounting Plate	L1200577
Protective Shield	L1200579
Consumables Kit	L1200581
Injection Port	L1200586
Solvent Bottle and Cap (drilled)	L1195019
Syringe Pump to Cell Tubing	L1200585
Syringe Pump to Needle Tubing	L1200587
Pack of 6, 16-position Racks for Test tube Vials	L1200589
Torque Driver 10 – 120 cNm	L9003631
Hex Bit 3.0 mm (for use with L9003631)	L9003632

Troubleshooting

NOTE: Troubleshooting as described in this chapter should be performed only by a qualified service engineer.

Problem	Possible Cause	Corrective Action
During Oil Analysis		
The results obtained for one or more properties are unacceptable.	The oil type entered during 'Prepare Run' is incorrect.	Ensure the correct oil type has been entered.
	The cell pathlength may not be correct.	Calibrate the flowcell (see *Calibrating the Pathlength of the Flowcell* on page 66).
	The flowcell may be dirty or have a build-up of material on the windows.	Clean the flowcell (see *Maintenance of the Flowcell* on page 87) and record a spectrum of the empty cell to ensure that it is clean. Ensure the pathlength is calculated correctly.
	The oil may not be representative of the whole sample.	Ensure that the portion sampled was collected roughly halfway through the filtration process.
Syringe Pump and Tubing		
Syringe pump is not pumping or stalls.	Syringe pump or tubing is blocked.	Flush out the syringe pump (see *Flushing the Syringe Pump* on page 77). Flush out the fluid system, (see *Checking the Fluid Path (Tubing)* on page 79).
	Loss of air gap due to tubing blocked, kinked or split.	Replace the defective tubing (see *Replacing the Tubing* on page 85).
	Lead Screw Encoder may be dirty.	Clean Lead Screw Encoder with air (see *Cleaning the Lead Screw and Lead Screw Encoder* on page 78).
Needle and Wash Port		
Cannot align needle.		Call for a PerkinElmer Service Engineer.
Needle dirty or blocked.	Residues from samples may be deposited in the needle.	Flush the needle using the Autosampler controls in the OilExpress software.
Sample spraying above transfer/wash port.	The needle is not aligned.	Align the needle (see *Calibrating the Autosampler* on page 60).
	The waste tubing is in the waste, causing a back-pressure.	Empty the waste container and/or raise the tubing out of the waste (see *Checking the Fluid Path (Tubing)* on page 79).

Sample/Solvent		
Solvent is not being drawn through.	The solvent bottle is empty.	Re-fill the solvent bottle and empty the waste container at the same time.
	A vacuum has built up in the solvent bottle, sucking the sides of the bottle inwards.	Make sure that there is a gap around the tubing through the lid of the wash bottle.
Sample/solvent is not being drawn through.	The tubing is split or leaking.	Examine it and change it if necessary (see *Replacing the Tubing* on page 85).
Solvent is leaking out.	Connections are loose.	Check all the connections to valves and pumps.
	The tubing is split or leaking.	Change the tubing (see *Replacing the Tubing* on page 85).
	The nut on the flange of the tube is not fitted correctly.	Refit the tubing and hand-tighten the nut at the end of the tubing.
During data collection		
The message **Sampler not responding** is displayed.	The Autosampler is switched off.	Make sure that the Autosampler is switched on.
	The Autosampler is not connected to the PC.	Make sure that the Autosampler is connected to the PC (see *Cable to PC* on page 43).
	The Autosampler cable is connected to the wrong COMM port on the PC.	Make sure that the Autosampler is connected to the PC using the correct COMM port (default is COMM 1) (see *Cable to PC* on page 43).
Sampling rate is slow.	Air is leaking into the system.	Check all the connections to valves and pumps, the tube-end fittings, and the connection to the top of the needle.
Sampling rate is getting slower.	The waste tubing is in the waste, causing a back-pressure.	Empty the waste container and/or raise the tubing out of the waste.
No spectrum was obtained during the run.	The sample was not present or the cell is not filling correctly.	Check all connections.
	The cell is not installed in the sample shuttle.	Install the cell in the front of the sample shuttle (see *Figure 24* on page 49).
Air bubbles in the sample.	Connections are loose or leaking.	Check all the connections to valves, flowcell and pumps, the tube-end fittings, and the connection to the top of the needle.
	The screws in the flowcell are loose.	Tighten the screws to correct torque (see *Deep Cleaning the Flowcell, Involving Disassembly* on page 88).

During data collection (cont.)		
Sample flow is poor.	Air is leaking into the system.	Check all the connections to valves and pumps, and the connection to the top of the needle.
	The tubing is worn.	Change the tubing (see *Replacing the Tubing* on page 85).
Bubbles are present in the flowcell.	Connections to the flowcell are reversed.	Make sure that the connections are correct.
Spectra are weak.	The energy reaching the detector is low because the tubing in the sample compartment is in the beampath.	Move the tubing out of the beampath.
Waste is not draining properly.	The waste tubing is immersed in the waste.	Empty the waste container and/or raise the tubing out of the waste.
General Autosampler mechanical failures:		
No movement on arm or pumps.	Flex cable defective.	Call for a PerkinElmer Service Engineer.
LED on Autosampler does not come on.	Main fuses blown.	Replace fuses. Call customer support (see *Changing the* Autosampler Fuses on page 84).
	Mechanical movement blocked.	Check movement mechanism for obstructions.
	CCU-9000 defective.	Call for a PerkinElmer Service Engineer.
Autosampler X, Y or Z-axis failures.		Call for a PerkinElmer Service Engineer.

If any of these problems persist, or if there are any other problems that you cannot correct, contact your local PerkinElmer office or agent.

Appendices

Appendix 1: Decontamination

Before using any cleaning or decontamination methods except those specified by PerkinElmer, users should check with PerkinElmer that the proposed method will not damage the equipment.

Customers wishing to return instrumentation and/or associated materials to PerkinElmer for repair, maintenance, warranty or trade-in purposes are advised that all returned goods must be certified as clean and free from contamination.

The customer's responsible body is required to follow the "Equipment Decontamination Procedure" and complete the "Certificate of Decontamination". These documents are available on the PerkinElmer public website:

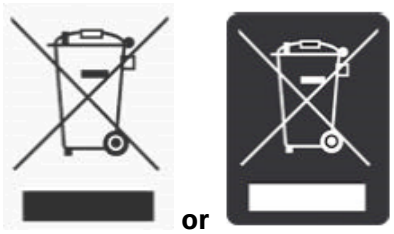
http://las.perkinelmer.com/OneSource/decontamination.htm

Alternatively, if you do not have access to the internet contact Customer Care:

Customer Care USA:	1-800-762-4000	(inside the USA)
(8:30 a.m. – 7 p.m. EST)	(+1) 203-925-4602	(outside the USA)
Customer Care Canada:	800-561-4646	
Customer Care EU:	0800 40 858	(Brussels)
	0800 90 66 42	(Monza)

If you are located outside of these regions, please call your local PerkinElmer sales office for more information.

Appendix 2: WEEE Instructions for PerkinElmer Products



A label with a crossed-out wheeled bin symbol and a rectangular bar indicates that the product is covered by the Waste Electrical and Electronic Equipment (WEEE) Directive and is not to be disposed of as unsorted municipal waste. Any products marked with this symbol must be collected separately, and in accordance with the regulatory guidelines in your area.

The objectives of this program are to preserve, protect and improve the quality of the environment, protect human health, and utilize natural resources prudently and rationally. Specific treatment of WEEE is indispensable in order to avoid the dispersion of pollutants into the recycled material or waste stream. Such treatment is the most effective means of protecting the customer's environment.

The requirements for waste collection, reuse, recycling, and recovery programs are set by the regulatory authority in your location. Contact your local responsible person (such as your laboratory manager) or authorized representative for information regarding applicable disposal regulations. Contact PerkinElmer at the web site listed below for information specific to PerkinElmer products.

Web address:

http://las.perkinelmer.com/OneSource/Environmental-directives.htm

Customer Care USA:	1-800-762-4000 (inside the USA)
	(+1) 203-925-4602 (outside the USA)
Customer Care EU:	0800 40 858 (Brussels)
	0800 90 66 42 (Monza)

Products from other manufacturers may also form a part of your PerkinElmer system. These other manufacturers are directly responsible for the collection and processing of their own waste products under the terms of the WEEE Directive. Please contact these manufacturers directly before discarding any of their products.

Consult the PerkinElmer web site (above) for manufacturer's names and web addresses.

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