

# Spe-ed SCF Product Line

## Educational System

Prime

## Laboratory Systems

Spe-ed SFE-Basic

Zoran

Spe-ed SFE-2

Spe-ed SFE-4

Helix

## Process Systems

Pilot Scale Systems

## Production Systems

Large Scale SCF Systems



610-770-0900

[www.appliedseparations.com](http://www.appliedseparations.com)

**Applied  
Separations**

# Spe-ed SFE-Prime

The *Spe-ed*<sup>TM</sup> SFE Prime is the newest SFE in our series of instruments for supercritical fluid processes. These systems meet the rigorous needs of day-to-day use in the classroom and are made for hands-on demonstrations. It is safe, simple to operate, fast and affordable, with features found in other, more expensive SFE systems.

The system features:

- temperatures to 150°C
- pressure up to 10,000 psi (690 BAR)
- pump flow rates up to 200mL/min\*
- control of flow rate to pressure vessel
- fully-adjustable, non-clogging micro-metering valve
- process vessels ranging in size from 5 to 100mL
- extract collected into SPE cartridges or standard glassware
- in-line trapping capabilities
- modifier addition capability
- liquid sample extraction capability
- multiple over-pressure safety devices

## Heating Compartment

- Flip-up cover for easy access
- Heater goes to 150 degrees C

## Micro-metering valve

- Straightforward adjustable design
- Non-clogging
- Simplified cleaning / rinsing
- Maintenance free
- Flow control +/- 1.8%
- Heated to compensate for Joule Thompson cooling

## Vessels

- 5 mL to 100 mL hand tightened
- Simplified shutoff valves
- Static and dynamic extractions

## High Pressure CO<sub>2</sub> Pump

- Reliable air driven
- Pressure 690 BAR (10,000 psi)
- 200 mL/min flow rate\*
- Digital pressure setting maintains a desired set point throughout the system
- Integrated cooling requiring no external chiller

\*flow rate based on incompressible liquid



## Temperature

- PID controllers maintain the precise temperature of the high pressure vessel and micro-metering valve.
- Independent sensors monitor the temperature of the vessel and micro-metering valve.

## Safety

- Built-in automatic over pressure and over temperature safeguards
- Audible alarm
- Pressure relief valve
- Rupture disc

# Spe-ed SFE-Basic

## Get Started with Supercritical Fluids Technology

The *Spe-ed™* SFE Basic is the base SFE in our series of instruments for supercritical fluid processes. The straightforward design of the *Spe-ed* SFE Basic includes the essential components required for supercritical fluid processes. This instrument is robust enough for rigorous use in the research lab, with a price tag that allows everyone to take advantage of the benefits of Supercritical fluids. It is safe, simple to operate, fast and affordable, with features found in other, more expensive SFE systems.

Supercritical Fluids excel in emerging industries like foods, natural products and nanotechnology where solvents can't be used.

The system features:

- temperatures to 240°C
- pressure up to 10,000 psi (680 BAR)
- pump flow rates up to 200mL/min\*
- control of flow rates to pressure vessel
- fully-adjustable, non-clogging micro-metering valve
- process vessels ranging in size from 5 to 100mL
- extract collected into SPE cartridges or standard glassware
- in-line trapping capabilities
- modifier addition capability
- liquid sample extraction capability
- multiple over-pressure safety devices

## Highlights of the Spe-ed SFE-Basic

### Heating Compartment

- Flip-up cover for easy access
- Temperatures to 240°C

### Micro-metering valve

- Straightforward adjustable design
- Non-clogging
- Simplified cleaning / rinsing
- Maintenance free
- Flow control +/- 1.8%
- Heated to compensate for Joule Thompson cooling

### Vessels

- 5 mL to 100 mL hand tightened
- Simplified shutoff valves
- Static and dynamic extractions

### High Pressure CO<sub>2</sub> Pump

- Reliable air driven
- Pressure 690 BAR (10,000 psi)
- 200 mL/min flow rate\*
- Digital pressure setting maintains a desired set point throughout the system
- Integrated cooling requiring no external chiller

### Temperature

- PID controllers maintain the precise temperature of the high pressure vessel and micro-metering valve.
- Independent sensors monitor the temperature of the vessel and micro-metering valve.

### Safety

- Built-in automatic over pressure and over temperature safeguards
- Audible alarm
- Pressure relief valve
- Rupture disc



\*flow rate based on incompressible liquid

# Zoran

The *Zoran* is the newest SFE in our series of instruments for supercritical fluid processes. These systems are perfect for when you need more features and capacity than the *Spe-ed* SFE-Basic, but less than the *Spe-ed* SFE-2.

The system features:

- temperatures to 180°C
- pressure up to 10,000 psi (690 BAR)
- 400mL/min Independent Static Pressure Control
- fully-adjustable, non-clogging micro-metering valve
- independent heating
- process up to (2) vessels ranging in size from 5 to 100mL
- extract collected into SPE cartridges or standard glassware
- in-line trapping capabilities
- modifier addition capability
- liquid sample extraction capability
- multiple over-pressure
- safety devices



# Spe-ed SFE-2

## 2-Vessel Simultaneous Oven-based Extraction System

The *Spe-ed* SFE-2 is the original SFE in our series of instruments for supercritical fluid extraction. Built in conjunction with the USDA, this system was designed to meet the rigorous needs of day-to-day use in the research lab. It is simple to operate, fast and affordable, with unique features not found in other SCF systems.

The system features:

- Data Logging
- Touch-screen Panel
- New Software
- Monitor from Smart Phone
- temperatures to 240°C
- pressure up to 10,000 psi (690 BAR)
- pump flow rates up to 400mL/min
- independent control of flow rates to each vessel
- fully-adjustable, non-clogging, variable restrictors
- parallel processing capabilities of up to 2 vessels from 5mL to 1.0L
- collection into SPE cartridges or standard glassware
- in-line trapping capabilities
- modifier addition capability
- multiple flow path capability
- extract directly from liquid samples



*Monitor from  
your smart phone*



# Spe-ed SFE-4

## 4-Vessel Simultaneous Oven-based Extraction System

Designed for every day use in the research lab, the *Spe-ed* SFE-4 is easy to use, cost-effective, and durable. The *Spe-ed* SFE-4 has all the advantages of the *Spe-ed* SFE-2 while expanding parallel processing capabilities up to four extractor vessels. This system doubles the processing capability of the *Spe-ed* SFE-2.

The system features:

- Data Logging
- Touch-screen Panel
- New Software
- Monitor from Smart Phone
- temperatures to 240°C
- pressure up to 10,000 psi (690 BAR)
- pump flow rates up to 400mL/min
- independent control of flow rates to each vessel
- fully-adjustable, non-clogging, variable restrictors
- parallel processing capabilities of up to 4 vessels from 5mL to 1.0L
- collection into SPE cartridges or standard glassware
- in-line trapping capabilities
- modifier addition capability
- multiple flow path capability
- extract directly from liquid samples



# Helix



## Basic Requirements for All Extractions

All extractions require at least these Applied Separations, Inc. components:

### Base unit

CO<sub>2</sub> Pump  
Pressure vessel assembly  
Recirculating bath (chiller)

### and these utilities:

A source of air delivered at 7 BAR  
Electrical power: 240v or 120v  
Source of liquid CO<sub>2</sub>

The Helix is made up of several “base” components. The basic components are put together in a variety of standard or custom configurations to make a unit to perform a specific function.

With the base system you will be able to use the same components to do separations and extractions as well as make nanoparticles, but not at the same time. This means on one day you can do extractions and on another day you can make nanoparticles.

With this system you will be able to use the same components to do each of these operations, but not at the same time. This means on one day you can do extractions and on another day you can make nanoparticles.

### Base Unit

The compact Base Unit, measuring 10" w X 16" d X 34" h is the starting platform for operations. Pressure vessel assemblies up to 1 liter are placed on the base unit's shelf. Input, output and vent lines are controlled by shutoff valves located on the front of the unit. Digital temperature and pressure indicators also on the front of the unit show pressure and temperature.

Pressure vessels are heated by specially designed band heaters which are plugged into the front of the base unit making for easy access. An additional CO<sub>2</sub> preheater is employed to ensure that the CO<sub>2</sub> is at the designed temperature before entering the pressure vessel. A back pressure regulator controls the flow of gaseous CO<sub>2</sub> if exiting to ambient collection or regulating the pressure in a downstream pressure vessel (e.g. cyclone separator).

A base unit with its vessel assembly can be linked to other base units for additional processing capabilities: cyclone separators, precipitation vessel, expansion vessel, etc.

# Helix

## Helix Configuration Options

Basic Configuration	#7409
Helix SCF Base Unit 240v	#7305
Touchpad Controller and Standard CO <sub>2</sub> Pump Module 240v	#7401
1 Liter Vessel Assembly	#7322
500mL Vessel Assembly	#7323
300mL Vessel Assembly	#7324
100mL Vessel Assembly	#7329
50mL Vessel Assembly	#6414
32mL Vessel Assembly	#6413
24mL Vessel Assembly	#6412
Standard Flow Meter	#7927
Standard Collector Vessel	#7735

## Basic Configuration Options

Modifier/Liquid Pump, Helix 240v	#7172
Recirculating Bath, Helix 240v	#7027
800mL CO <sub>2</sub> Pump Module 240v	#7316
Stirring Assembly - stirrer, controller	#7320

## Variety of Flow Meters

CO <sub>2</sub> Recycle Module Chiller, Level Indicator, etc.	#7399
--	-------



Vessel with Stirrer Assembly



Collection



Pressure Relief Device



Touchpad System Control



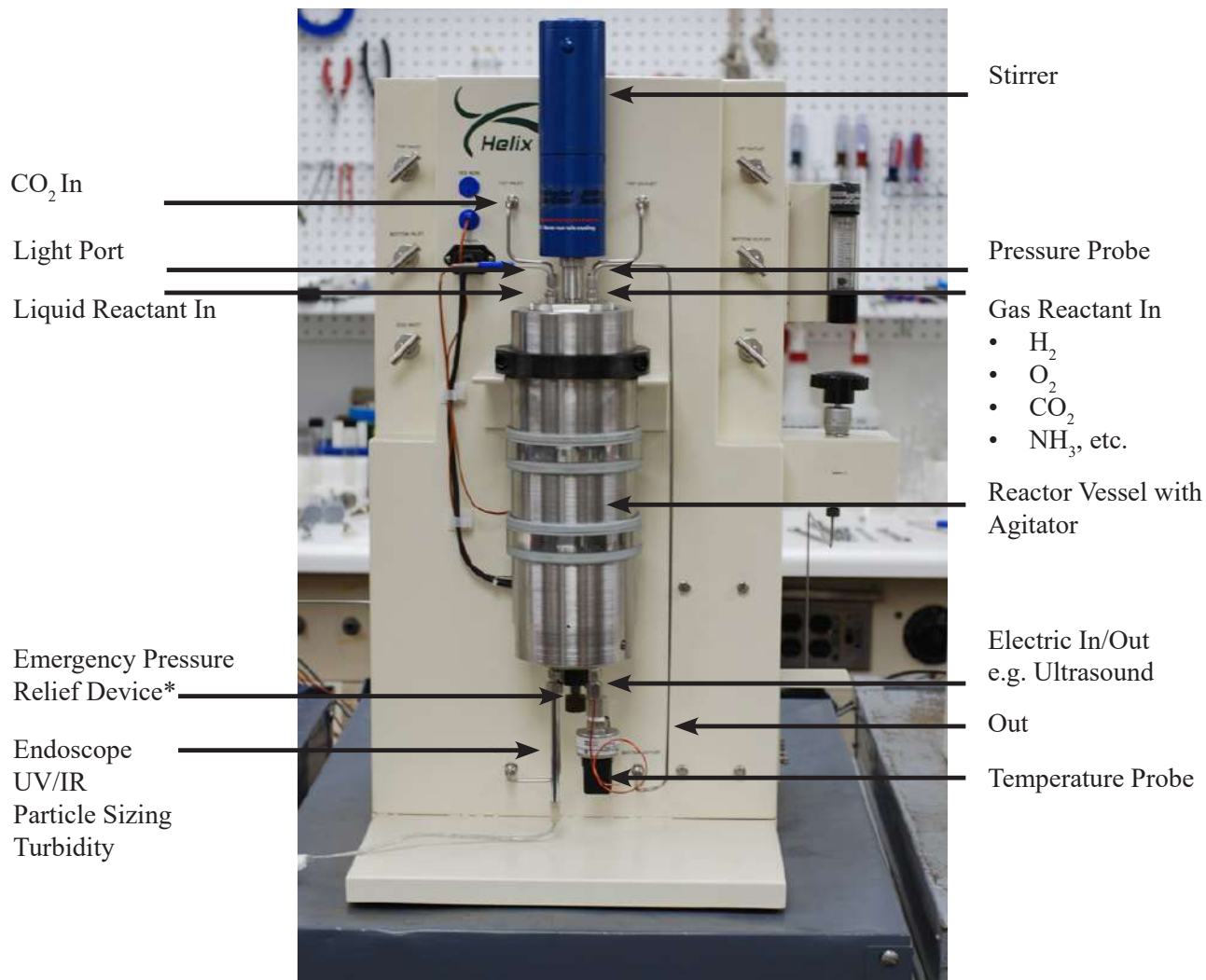
RESS collector



Basic Helix system with the separator module.



# Helix



Endoscope



UV/IR



Monitor Meters

- Spectrophotometer



Stirrer Shaft/Impeller

- Variable length
- Interchangeable impellers



Close-up of the top and bottom vessel ports.

\*Patent Pending

# Helix

## Cryo Cooler

Low pressure/ambient aluminum containers are available to collect a variety of extracts. Should the extract be highly viscous heat can be applied, or if volatile, chilling can be applied.



## Stirrer

Applied Separations now offers new stirrers to go into their extraction/ reaction vessels via the 5-Port cap that allows access to the inside of the vessel during your process.



## Pump Module

There are two standard CO<sub>2</sub> pumps (#7321 and #7316). These are air-driven, liquid pumps capable of delivering CO<sub>2</sub> from a cylinder (nominally 60 BAR at room temperature) to a pressure of 690 BAR. Because they are pneumatic, they are inherently more compact, safer, cleaner, quieter and requiring less maintenance than either electric or hydraulic pumps. In both pumps, the pressure is set and shown by a digital readout. There is another gauge to show the air pressure.

The stirrers are rated to 10,000 PSI, 650°F, and go up to 3,000 rpm. The instrument control panel includes a digital display to monitor rpm. Stirrers are available with different shaft lengths, with a wide variety of impellers available to attach to the bottom of the stirrer.

## Modifier/Liquid Pump

Liquid pumps may be necessary in several operations when using the Helix: adding polar modifiers, introducing solvents during PCA and for the operation of the countercurrent column.

## Recirculating Bath



The *Spe-ed* RCB for Helix (#7027) (820 BTU/hr, -10 C) is a specifically designed recirculating cooling bath that chills the CO<sub>2</sub> to liquidity. It is microprocessor controlled, with a small footprint and nearly noise free.

The standard co-solvent pump (#7172) is a microprocessor controlled pump delivering 690 BAR at adjustable flow rates up to 12mL/min. Pumps having higher flow rates are available.



## Pressure Vessel Assemblies

316 Stainless steel pressure vessels for the Helix are hand-tightened and range in size from 24ml to 1,000ml. The assembly is comprised of the pressure vessel, heating elements, electrical input cable, and insulation. Standard sizes are

7972	5mL Vessel	1" O.D. x 5.125" O.L. .390" I.D. x 2.24" I.L.
7972	10mL Vessel	1" O.D. x 5.125" O.L. .560" I.D. x 2.24" I.L.
7973	24mL Vessel	1" O.D. x 8.875" O.L. .560" I.D. x 5.9" I.L.
7974	32mL Vessel	1" O.D. x 10.5" O.L. .560" I.D. x 8" I.L.
7975	50mL Vessel	1" O.D. x 15.25" O.L. .560" I.D. x 12.72" I.L.
7329	100mL Vessel	2.25" O.D. x 9.57" O.L. 1.25" I.D. x 4.97" I.L.
7324	300mL Vessel	3.5" O.D. x 11.42" O.L. 2" I.D. x 5.87" I.L.
7323	500mL Vessel	4.75" O.D. x 9.49" O.L. 3" I.D. x 4.49" I.L.
7322	1000mL Vessel	4.75" O.D. x 13.63" O.L. 3" I.D. x 8.62" I.L.



# Helix 1000BAR

Increasing supercritical CO<sub>2</sub> extraction pressures up to 1000 bar may upgrade existing industrial processes operating at sub optimal conditions as well as lead to the discovery of effective supercritical conditions for new products.

At Applied Separations, we have a proven commitment to advancing Supercritical Fluids technology and have worked with companies all over the world to incorporate SCF into their processes. Thanks to a top-notch R&D team, in-house engineers, and visionary approach, we're working hard to develop and enhance applications of this green technology in many unexpected industries.

The system features:

- **Tablet Control**
- **New Software**
- **Pressure up to 15,000 PSI**
- **Temperatures up to 240°C**
- **Parallel Processing Capabilities**
- pump flow rates up to 400mL/min
- independent control of flow rates to each vessel
- fully-adjustable, non-clogging, variable restrictors
- parallel processing capabilities of up to 2 vessels from 100mL to 1.0L
- collection into SPE cartridges or standard glassware
- in-line trapping capabilities
- modifier addition capability
- multiple flow path capability
- CO<sub>2</sub> pump (1000 Bar)
- CO<sub>2</sub> preheater
- Heated Extraction Vessel ( 25mL to 1 liter)



## Higher Pressure Extraction System

### *Supercritical Fluids at Higher Pressure*

Most supercritical CO<sub>2</sub> extraction equipment and commercial production plants operate at pressures less than 500 bar because equipment costs increase significantly at higher pressures. This upper limit in pressure results in sub optimal extraction of many high value products. Results from supercritical fluid extraction experiments indicate that distinct solubility maxima are achieved between 650 – 1000 bar for many valuable compounds including:

- Sitosterol
- Beta – Carotene
- Cryptoxanthin
- Lutein
- Zeaxanthin
- Astaxanthin

# Pilot Systems

## Multipurpose, Expandable SFE Pilot System

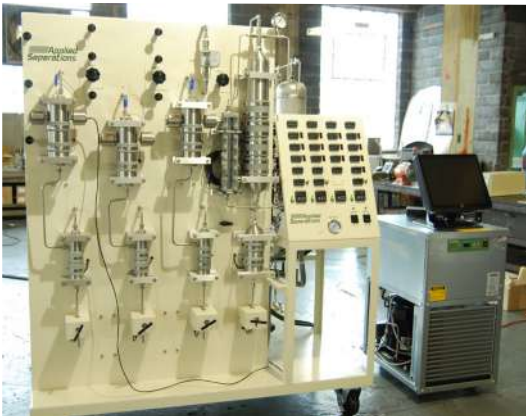
Applied Separations, Inc. offers SCF systems in any size and configuration. Although the size of a pilot system versus a production system is arbitrary, customarily, Applied Separations designates pilot systems as having extraction/reaction vessels from 5 liters to 80 liters. Greater than 80 liters, we consider production scale.

Applied Separations, Inc. will work with you one-on-one to design your custom, multipurpose, movable pilot plant/small production system. The system may be as straight forward as a manual system having one extractor vessel and venting to atmosphere to an automated system having multiple extraction/reaction vessels with multiple separators, recycling the CO<sub>2</sub>.



Manufacturing  
Supercritical Systems  
for 30 years

Numerous System Options  
...too many to list, but here are a few...



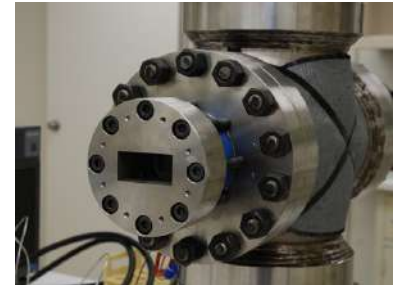
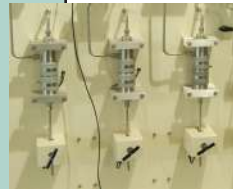
- Temperatures ambient to 650° C
- Pressures from low to very high, more than 2000 BAR
- Single or multiple separators
- Particle formation... organic/inorganic
- Counter-current Columns
- Automated control, Automated closures
- View cells, video interface
- Manual or sophisticated automated software
- Crossover networks
- Supercritical water
- Supercritical propane and other gases and liquids
- Beaming Microwave through SCF pressure vessels
- Ultrasonic interfaces
- In-vessel UV/Vis measurements
- Cleanroom environments... medical or IC
- Specialty basket designs

# Pilot Systems

Multipurpose, Expandable SFE Pilot System

## Some Uses for SCF Technologies

- Aerogel Drying
- Medical Implant Cleaning
- Metal Injection Molding/Powder Injection Molding
- Extractions of Natural Products
- Critical Cleaning
- Textile Dyeing
- Essential Oils - Flavors and Fragrances
- Nanoparticles
- Coatings
- Electronic Cleaning
- Enzymatic Reactions
- Reactions
- Foods
- Hydrogenation
- Impregnations
- Pharmaceuticals
- Subcritical Water
- Polyolefin Fractionation
- Critical Point Drying
- Archeological Artifact Drying



# Custom Large Scale Systems

Not all laboratories are the same, and neither are all projects. We can help you customize our systems to meet your needs. Production scale systems from Applied Separations offer all the same options and advantages of the Pilot Scale systems.

## Computer control/Automation

Applied Separations offers you a completely computer controlled/automated system for use in your laboratory. Ask us how our automated technology can help you.



# Custom Large Scale Systems



# Why Supercritical Fluids?

## Supercritical Fluids Revolutionize Your Processes

No longer an exotic laboratory curiosity, but now a cost-effective tool to improve your process development.

No matter what your business...

### Natural products

- Medicinals
- Biomass extractions
- Fragrances/essential oils

### Pharmaceuticals/foods

- Natural products
- Enzymatic reactions
- Reaction cleanups
- Hydrogenations

### Material Science

- Nanoparticles
- Aerogels
- Coatings
- Impregnations
- Metal Injection Molding (MIM)

### Electronics

- IC Cleaning
- Resist developer
- Micro Electro-Mechanical Machines (MEM) cleaning

### Textiles

- Dyeing
- Impregnations

### Cleaning

- Critical cleaning machine parts
- ICs
- MEMs

### Subcritical/Supercritical Water

Carbon dioxide is in its supercritical fluid state when both the temperature and pressure equal or exceed the critical point of 31°C and 73 atm (see diagram). In its supercritical state, CO<sub>2</sub> has both gas-like and liquid-like qualities, and it is this dual characteristic of supercritical fluids that provides the ideal conditions for extracting compounds with a high degree of recovery in a short period of time.

By controlling or regulating pressure and temperature, the density, or solvent strength, of supercritical fluids can be altered to simulate organic solvents ranging from chloroform to methylene chloride to hexane. This dissolving power can be applied to purify, extract, fractionate, infuse, and recrystallize a wide array of materials.

Because CO<sub>2</sub> is non-polar, a polar organic co-solvent (or modifier) can be added to the supercritical fluid for processing polar compounds. By controlling the level of pressure/temperature/modifier, supercritical CO<sub>2</sub> can dissolve a broad range of compounds, both polar and non-polar.

## Supercritical Fluids can revolutionize your processes!

### A Supercritical Fluid

- is fast and selective
- allows for reduced extraction and purification steps
- provides decreased processing time
- has reduced organic solvents
- gives higher yield with lower cost

