HOCHDRUCKTECHNIK UND ANLAGENBAU

SITEC SIEBER ENGINEERING AG

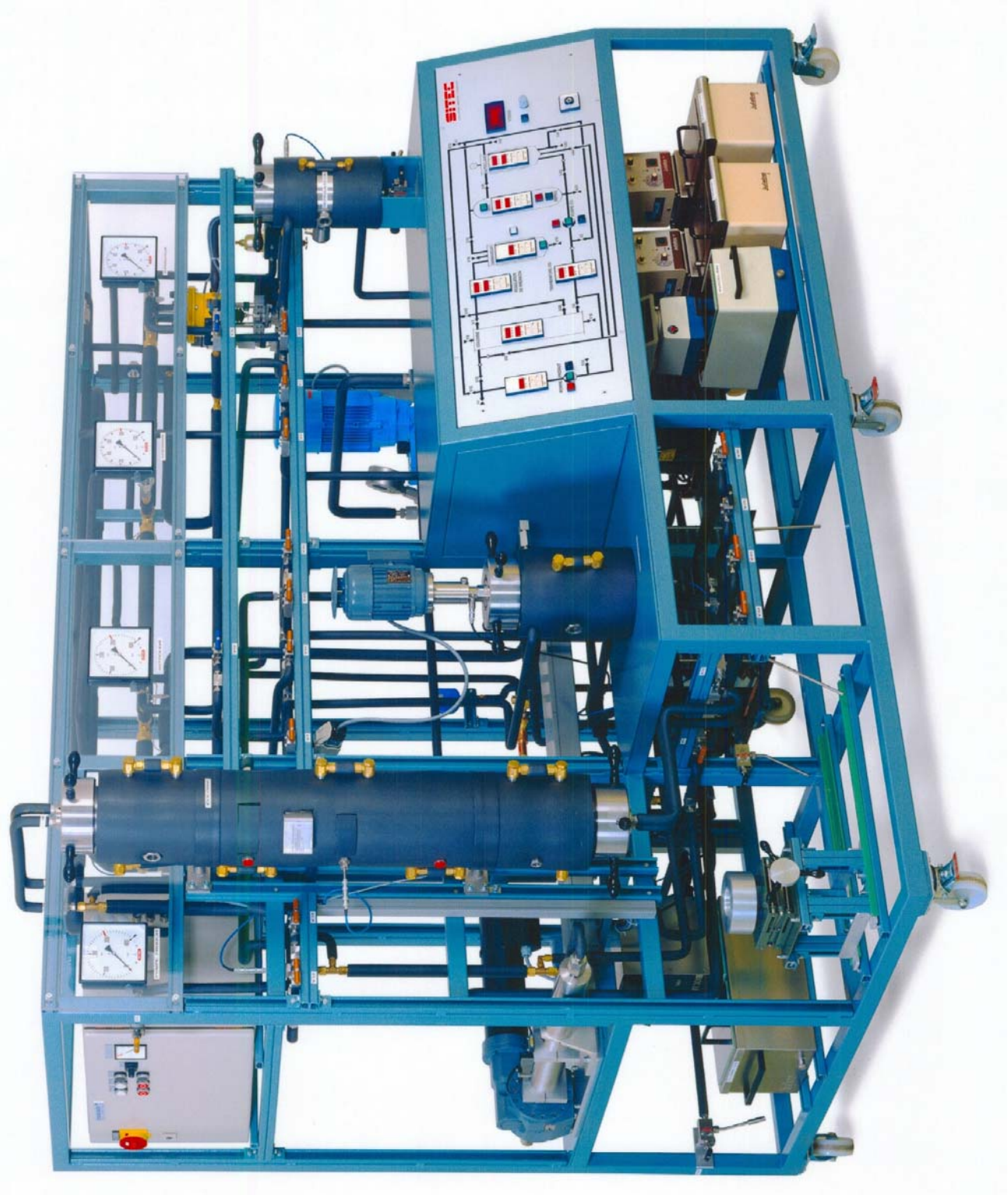
CH-8124 MAUR/ZÜRICH, ASCHBACH 621, TEL. +41 (0)44 982 20 70, FAX +41 (0)44 982 20 79, E-MAIL: SIEBER@SITEC-HP.CH

HP-MICRONISATION (RESS)

and

HP-SPRAY DRYING (GAS)

- High Pressure Pilot Units for RESS Process
  (**R**apid **E**xpansion of **S**upercritical **S**olutions)
- High Pressure Pilot Units for GAS Process
  (**G**AS **A**nti-**S**olvent)
- Multipurpose Pilot Units for RESS, GAS and SFE
- Diamond Nozzle Set



SITEC-Sieber Engineering AG
Aschbach 621
CH-8124 Maur/Zürich

Tel +41 44 982 20 70
Fax +41 44 982 20 79
Homepage www.sitec-hp.ch

Advantages

- Production of very fine powders
- Production of very uniform powders
- Shape and size of crystals changeable in a wide range by modifying process parameters

Applications

- Formulation of pharmaceutical products
- Enrobing of active agents
- Production of colour pigments

Picture page 1:
Multipurpose High Pressure Pilot Unit for Micronisation (RESS), Spray Drying (GAS) as well as for the Extraction of solids using supercritical gases as solvents (300 bar, 80 °C, 18 kg/h CO2 flow, spray column 6.4 litre (ID 90 mm) with diamond nozzle, 1 litre stirrer vessel for product pre-treatment and as extractor, motorised piston pump for pulsation-free injection of liquid product, separator 1.2 litre)

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Multipurpose High Pressure Pilot Unit for Micronisation and Spray Drying (Technical Description)

This turn-key Multipurpose Pilot Unit is assembled in a mobile frame and is built for the following operating conditions:

Extraction / Spray Pressure:	75 – 300 bar (higher pressures optional)
Extraction / Spray Temperature:	ambient – 80 ºC (higher Temperatures optional)
Separation Pressure:	40 – 70 bar depending on the storage bottle pressure (higher pressures optional)
Separation Temperature:	ambient – 60 ºC

In the spray drying or micronisation mode, the Pilot Unit is operated semi-continuously during one stroke of the motorized piston pump P5. Extracting solutes from solid material, the unit is used in the batch mode.

The following **modes of operation** are possible:

A. High Pressure Spray Drying (GAS-Process)

In the **spray drying mode** (**G**as **A**nti-**S**olvent Process), the solid material (for instance an active agent) is dissolved in a conventional liquid solvent. A high pressure vessel B1 equipped with a magnetic stirrer is used to prepare the fluid mixture. In this stirrer vessel B1 the mixture is heated up to the desired spray temperature.

The motorised piston pump P5 which generates a well defined and absolutely pulsation-free flow is used to pump the solution through the spray nozzle into the spray column B3.

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While the very fine droplets which have been generated in the diamond nozzle fall down to the bottom of the column B3, the liquid solvent is extracted by CO2 flowing in co- or counter-current (depending on chosen mode of operation). The droplets are “dried” and reach the bottom of the column B3 as a very fine powder which is collected in an especially designed collecting basket.

The extracted liquid solvent is carried out of the column B3 by the supercritical CO2 and is separated from the gas inside the separator B2. The clean CO2 leaving the separator B2 is re-condensed and re-pumped up to the desired pressure.

The powder which has been collected during the experiment in the collecting basket can be removed by opening the quick opening closure at the bottom of the spray column B3 after the experiment.

B. Supercritical Fluid Extraction (SFE)

The stirrer vessel B1 can also be used as an extractor for solid products. In this case the magnetic stirrer has to be dismounted.

The solid product is introduced into the extractor B1 in a cylindrical basket with filter elements on both ends. These filter elements retain the product but are permeable for the solvent fluid and the dissolved extract. The solvent fluid dissolves the extract flowing upstream (or downstream) through the solid product. The extract is carried over to the separator B2 by the supercritical gas.

Before entering the separation vessel B2 the pressure is reduced by a control valve C1 lowering the solvent power of the carrier gas to practically zero. There are three distinct phases entering the separation vessel: Liquid CO_2 , gaseous CO_2 and the extract. The extract drops to the bottom of the separator B2 from where it can be removed through a hand valve. In the separation vessel B2 a liquid level is maintained in order to improve the separation of the extract. The entering liquid CO_2 is evaporated continuously at moderate temperature.

The gas leaving the separator B2 is re-condensed and re-pumped as described before.

C. Combination of SFE and HP-Micronisation (RESS-Process)

In the RESS mode (**R**apid **E**xpansion of **S**upercritical **S**olutions) the vessel B1 is used as an extractor.

The active agent is introduced into the extractor B1 in a cylindrical basket with filter elements on both ends. These filter elements retain the product but are permeable for the solvent fluid and the dissolved active agent.

The supercritical fluid, saturated with active agent, is then directly injected through a diamond spray nozzle into the spray column B3. The sudden and drastic decrease in solubility generates a huge number of crystallisation germs and thus a huge number of very fine particles.

The particles generated fall down to the bottom of the spray column B3, are collected in an insert and can be removed after the experiment.

Basically the high pressure pilot unit consist of a pressure generating section, of the spray column B3, the stirrer autoclave B1 and the separator B2.

In the condenser W3 the gas is condensed and in the following metering pump P1 brought up to the chosen extraction or spraying pressure. In the downstream heat exchanger W1 the solvent fluid is heated up to the required extraction or spraying temperature which means that the solvent fluid has reached the extraction or spraying conditions when entering the spray column B3 or the extractor B1.

The high capacity diaphragm metering pump P1 delivers contaminant free supercritical fluid. Its capacity is adjustable from 10 to 100. As an option the mass flow may be measured using a Coriolis mass-flowmeter.

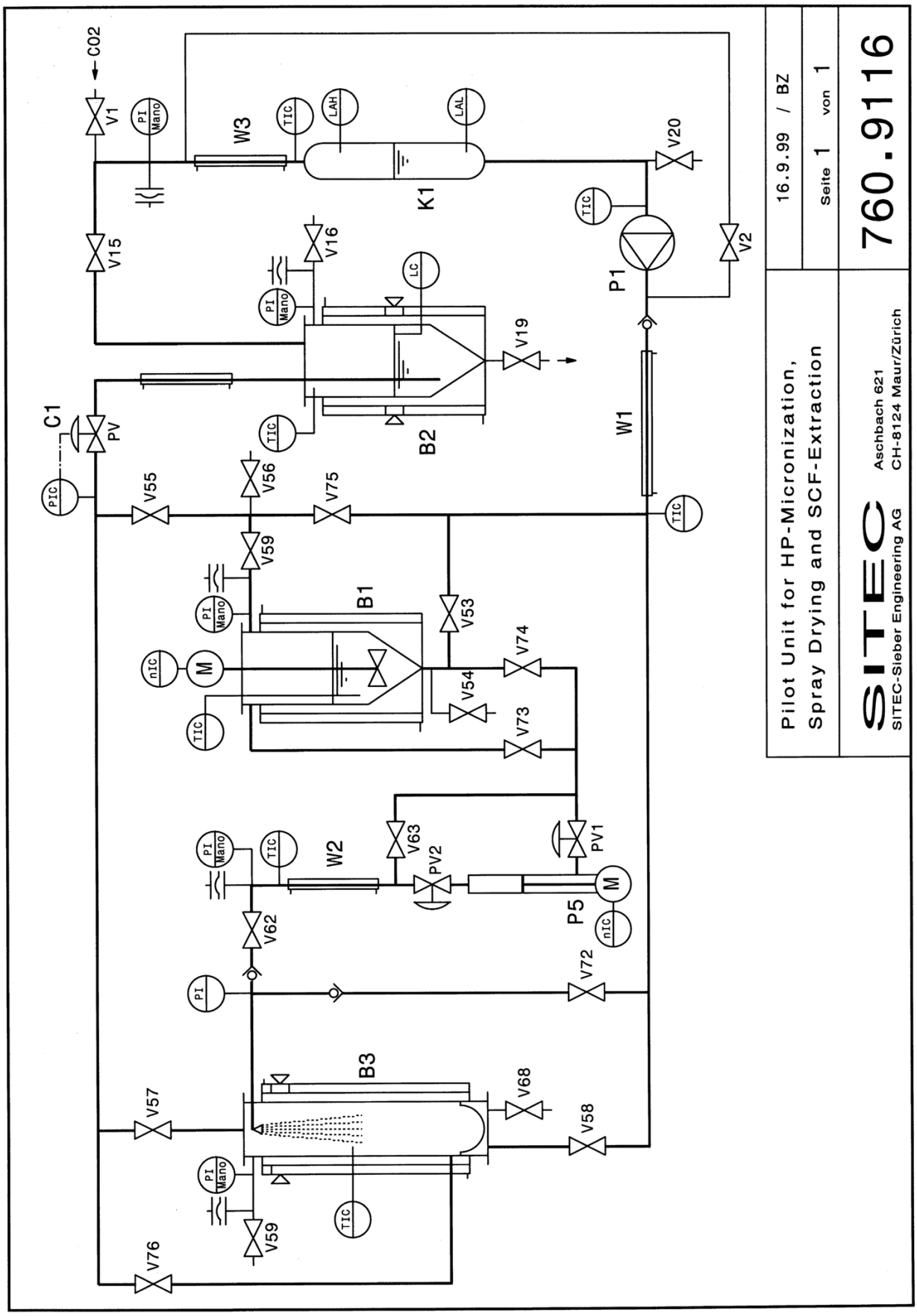
The spray nozzle and the spray cone can be observed through the installed sight glasses and as an option can be transmitted on a TV-screen or sent to a Video recorder.

The vessels are easily accessible and the quick opening closures are hand operated.

For reliable scale-up and economical reasons the design of the system is based on pumping the supercritical fluid rather than compressing it in the non-relevant and costly gaseous state.

All relevant data are indicated on digital displays on the front panel flow sheet and, as an option, may be brought up to a recorder or to a Personal Computer.

Various additional options are available, such as larger spray columns/extractors with capacities of up to 20 litre; higher pressures, temperatures and mass flows.


CO2
V1
PI Mano
W3
TIC
LAH
LAL
V20
K1
V15
V16
LC
P1
V2
V19
B2
C1
PV
PIC
V55
V56
V75
W1
V59
B1
V53
nIC
M
V74
V54
V73
W2
V63
PV2
PV1
P5
V62
V72
PI
B3
V57
V68
V58
V76
Pilot Unit for HP-Micronization,
Spray Drying and SCF-Extraction
16.9.99 / BZ
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760.9116
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Standard Design and Options (Please mark required data)

Max. operating pressure:		**300 bar**	500 bar	(700 bar)
Fluid capacity:	10 l/h	☐	☐	☐
	18 l/h	☐	☐	☐
	30 l/h	☐	☐	
	50 l/h	☐	☐	
	100 l/h	☐		

Max. operating temperature: ☐ **80 °C** ☐ 120 °C ☐ 150 °C ☐ 200 °C
☐ .....

Supercritical solvent: ☐ **carbon dioxide** ☐ .....

Stirrer vessel capacities / extractor capacities:
☐ **1 litre (with 600 ml basket insert for RESS/SFE)**
☐ 2 litre (with 1.2 litre basket insert for RESS/SFE)
☐ 4 litre (with 2.4 litre basket insert for RESS/SFE)
☐ 6 litre (with 3.9 litre basket insert for RESS/SFE)
☐ 10 litre (with 7 litre basket insert for RESS/SFE)
☐ 20 litre (with 14 litre basket insert for RESS/SFE)
☐ .....

Spray column internal diameter: ☐ ∅ **90 mm** ☐ ∅ 110 mm
☐ ∅ 160 mm ☐ .....

Spray column internal length: ☐ **1 m** ☐ 2 m ☐ .....

Liquid educt capacity: ☐ **3.5 l/h** ☐ 10 l/h ☐ 18 l/h ☐ .....

Options:

☐ Semi continuous discharging of solid products
☐ Diamond nozzle set
☐ Mass-Flowmeter for ☐ carbon dioxide (recommended), ☐ liquid product ☐ entrainer
☐ Intermediate separation system(s) ☐ 1 ☐ 2 ☐ 3
☐ Entrainer system
☐ Data acquisition system by PC
☐ Continuous recovery of ☐ extract ☐ entrainer
☐ Preparation of rack for RETROFIT of a(n) ☐ extractor ☐ column ☐ separator
☐ Camera system with endoscope: ☐ black/white ☐ colour

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