



## INSTYTUT NAWOZÓW SZTUCZNYCH

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**Aleja Tysiąclecia Państwa Polskiego 13a**  
**24-110 Puławy, Poland**

Projekt/zadanie:

Tytuł  
opracowania:

**Technical specification**

Tytuł  
dokumentu:

**High pressure pilot plant components**

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Rewizja

Data

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**Object of the order** are the components of high pressure pilot plant with complete equipment and its assembly designed for the following conditions:

Plant application: extraction of natural products  
 Solvent: CO<sub>2</sub> or CO<sub>2</sub> + entrainer (water or ethanol)  
 Design pressure: 1200 bar  
 Design temperature: 100 °C  
 Operating pressure: up to 1000 bar  
 Operating temperature: up to 80°C  
 Separation pressure: 1-stage: 400 bar, 2-stage: 80 bar  
 Separation temperature: up to 80 °C  
 Instrument air pressure: 6 bar absolute (gauge pressure - 5 bar) available  
 Ordered equipment should be mounted into a steel frame.  
 Ordered equipment should be agree EU Standards.

Buyer possess : CO<sub>2</sub> pump 230 l/h, 1000 bar  
 entrainer pump 5 l/h, 1000 bar  
 complete cooling unit 40 kW (thermal)

The Supplier should develop a proposal of scheme of all components connection. Detail engineering and P&I-Diagram of the plant are confidential and should be agreed between Supplier and Buyer.


## Scope of Supply

### 1. 2 Extractors with CO<sub>2</sub> preheaters

Volume: about 40 l each  
 Design data: pressure: 1200/-1 bar, temperature: 120/-10 °C  
 Closure: quick acting and bolted  
 Material: all parts in contact with medium in stainless steel  
 Equipped with heating jacket and coil (CO<sub>2</sub> preheater 10 kW).  
 Equipped with 4 special internal baskets.

### 2. 1 Separator 400 bar

Volume: about 20 l  
 Design data: pressure: 400 /-1 bar, temperature: 120/-10 °C  
 Closure: quick acting and bolted  
 Material: all parts in contact with medium in stainless steel  
 Equipped with heating jacket and internal heating coil

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### 3. 1 Separator 80 bar

Volume: about 20 l  
 Design data: pressure: 80/-1 bar, temperature: 120/-10 °C  
 Closure: quick acting and bolted  
 Material: all parts in contact with medium in stainless steel  
 Equipped with heating jacket

### 4. 1 CO<sub>2</sub> - working tank with condenser

Volume: about 150 l  
 Design data: pressure: 80/-1 bar, temperature: 100 / -60 °C  
 Equipped with cooling jacketed  
 Internal condenser: cooling coil of CO<sub>2</sub> in jacket (20 kW)  
 Material: all parts in contact with medium in stainless steel

### 5. 1 Liquid CO<sub>2</sub> Cooler

Type: coil heat exchanger  
 Capacity: about 2,5 kW  
 Material: all parts in contact with medium in stainless steel

### 6. 1 Evaporator

Type: coil or double- tube heat exchanger  
 Capacity: about 22 kW  
 Material: stainless steel

### 7. 1 Heating unit

Capacity: about 60 kW  
 Energy: saturated steam - 3 bar gauge, max. – 4 bar gauge,  
 Comprising: 1 storage vessel with steam coil, 4 circulating pumps (see table on next page), and complete piping

### 8. 5 Pumps

Preliminary list of pumps for heating unit: (items 1 ÷ 3) and for CO<sub>2</sub> working tank with condenser ( item 4).



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Item	Flow-rate, kg/h	Medium	Pressure- drop, bar	Operating temperature, °C	Pcs
1	÷ 1500	Hot water	4	90	2
2	÷ 500	Hot water	4	90	1
3	÷ 3000	Hot water	4	90	1
4	÷ 5 000	Ethylene- glycol solution	5	-10	1

## 9. Armatures

Armatures within High Pressure Processing Area, i.e. high and medium pressure valves as well as control valves for utilities.

### 9.1 Control valves - preliminary list:

No.	Item	Flow-rate, kg/h	Size, mm	Medium	Design pressure, bar	Operating temperature, °C	Pcs
1	PV	0 ÷ 300	8	CO <sub>2</sub>	1200	80	1
2	PV	0 ÷ 300	8	CO <sub>2</sub>	400	80	1
3	PV	0 ÷ 50	6	CO <sub>2</sub>	1200	80	1
4	PV	0 ÷ 5000	45	ethylene- glycol solution	6	-10	1
5	TV	0 ÷ 25	15	steam	10	130	4
	TV	or 0 ÷ 2000	or 15	or hot water	or 10	or 90	or 4
6	TV	0 ÷ 200	32	steam	10	130	1



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## 9.2. Safety valves - preliminary list:

No	Mark	Flow-rate, kg/h	Medium	Design pressure, bar	Operating temperature, °C	Pcs
1	PSV	300	CO <sub>2</sub>	1200	80	3
2	PSV	300	CO <sub>2</sub>	400	80	1
3	PSV	300	CO <sub>2</sub>	80	80	2
4	PSV	50	CO <sub>2</sub>	50	80	2
5	PSV	25	Entrainer (water or ethanol)	1200	30	1
6	PSV	50	Ethylene-glycol Solution	6	-10	1
7	PSV		Hot water	10	90	4

**Notice: In case of need a rupture discs should be used additionally.**

## 9.3. Cut-off valves and check valves - preliminary list:

No	Function / type of valve	Size	Medium	Design pressure, bar	Operating temperature, °C	Pcs
1	cut-off, straight	8	CO <sub>2</sub>	1200	80	4
2	cut-off, needle	6 and 8	CO <sub>2</sub>	1200	80	13
3	cut-off, straight	8	CO <sub>2</sub> +extract	400	80	1
4	cut-off, straight	8	CO <sub>2</sub> +extract	80	80	1
5	cut-off, ball valve	6	CO <sub>2</sub>	1200	80	2
6	cut-off, ball valve	6	CO <sub>2</sub>	400	80	1
7	cut-off, ball valve	15	Heating water	10	90	20
8	cut-off, ball valve	6	Entrainer	1200	30	2
9	cut-off, ball valve	15	Demineralized water	6	20	3
10	cut-off, ball valve	50	Ethylene-glycol solution	6	-10	2
11	cut-off, ball valve	25	Ethylene-glycol solution	6	-10	4
12	cut-off, needle valve	6	CO <sub>2</sub>	1200	80	3
13	cut-off, needle valve	6	CO <sub>2</sub>	80	80	8

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14	cut-off, needle valve	6	CO <sub>2</sub>	400	80	1
15	cut-off, needle valve	32	Steam	10	130	1
16	check valve	6 and 8	CO <sub>2</sub>	1200	80	4
17	check valve	6	CO <sub>2</sub>	400	80	1
18	check valve	15	CO <sub>2</sub>	80	80	2
19	check valve	6	Entrainer (water or ethanol)	1200	80	1

**Notice:** Number, type and size of valves may be changed according to agreed detail engineering and P&I Diagram of the plant

## 10. Steel frame (support for equipment)

Comprising a manually basket tilting device and a corresponding monorail (pillat slewing jib type).

Supplier should define final dimensions and weight of the steel frame with all equipment. Buyer disposes of free space for steel frame (long x width x high) 7,0 x 2, 7 x 3,7 m.

## 11. Measuring, control visualization and archiving system


Consisting of:

- pressure control system
- temperature control system
- 1 CO<sub>2</sub> mass flow meter
- local temperatures and pressure gauges
- PC and software,
- Unit control, process visualization, alarm and data registration with IBM compatible computer

The control system will consist of engineering and operating station (PC), process station (DCS), Ethernet switch. The plant will be operated by a PC based control system interacting with a DCS. The scope of the PC based control system includes control logic and software. (Documentation in English).

The PC based control system enables:

- Indication of all relevant process temperatures, pressures and CO<sub>2</sub> flow rate
- Registration of all relevant process temperatures, pressures and CO<sub>2</sub> flow rate
- Control of all relevant process parameters
- All parameters can be recorded and stored in the PC and will be shown in graphics on screen,
- Setting of set points of pressure and temperature controllers

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- All system set points are configured on these screens
- Trend files, alarm list and log-file data storage (review of historical data) for a certain period
- Process control, including alarm units control, security management
- Manually control – only for maintenance and test runs

Preliminary list of control item:

Symbol of control item	Measured/adjusted parameter and function	Operating value	Range	Pcs	Remarks
PIR	CO <sub>2</sub> pressure transducer, indication and registration	1200 bar	0 ÷ 1600 bar	6	4-20 mA, DCS
PI	local indication	1200 bar	0 ÷ 1600 bar	4	Local, manometer
PIR	CO <sub>2</sub> pressure transducer, indication and registration	400 bar	0 ÷ 600 bar	1	4-20 mA, DCS
PI	local indication	400 bar	0 ÷ 600 bar	1	Local ,manometer
PIR	CO <sub>2</sub> pressure transducer, indication and registration	80 bar	0 ÷ 160 bar	3	4-20 mA, DCS
PI	local indication	80 bar	0 ÷ 160 bar	3	Local, manometer
PIS	CO <sub>2</sub> pressure transducer, indication and switch	50 bar	0 ÷ 60 bar	3	4-20 mA, DCS
GO	Limit switch for closures and valves	-	-	14	DCS
PI	local indication for steam, hot and coldwater, and brine	3 bar	0 ÷ 10 bar	10	Local, manometer
TIR	CO <sub>2</sub> temperature, indications and registration	10 ÷ 80°C	0 ÷ 150°C	6	DCS, temp, module 120 MPa
TIR	CO <sub>2</sub> temperature, indications and registration	10 ÷ 80°C	0 ÷ 150 °C	1	DCS, temp, module 40 MPa
TIR	CO <sub>2</sub> temperature, indications and registration	10 ÷ 80°C	0 ÷ 150 °C	4	DCS, temp. module 8 MPa
TIRC	Water temperature, control, indication and registration	80°C	0 ÷ 100 °C	4	DCS, temp. module 1 MPa
TIRC	Brine temperature, control, indication and registration	-10 °C	-50 ÷ +50 °C	2	DCS, temp. module 1 MPa
TI	Local indication (water)	0 ÷ 100 °C	0 ÷100 °C	4	
TI	Local indication (steam)	0 ÷ 150 °C	0 ÷150 °C	1	



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TI	Local indication (brine)	-10 – +0 °C	-50 ÷ +50°C	4	
FIRQ	Mass-flow meter of CO <sub>2</sub> indication, totalizer and registration	250 kg/h	35 ÷ 350 kg/h	1	4-20 mA, DCS
FRS	Steam flowrate meas., indication, totalizer and registration	200 kg/h	0 ÷ 250 kg/h	1	4-20 mA, DCS
FIRS	Demineralized water flowrate meas., indication, totalizer and registration	250 l/h	0 ÷ 1 m <sup>3</sup> /h	1	4-20 mA, local / DCS
FI	Local indication, brine	5000 l/h	0 – 10 m <sup>3</sup> /h	1	
FI	Local indication, brine	500 l/h	0 – 1 m <sup>3</sup> /h	3	
FI	Local indication, hot water			4	
LRAHL	Liquid CO <sub>2</sub> - level in working tank, indication and registration, alarm from low and high-level	200 ÷ 1000 mm	0 ÷ 1500 mm	1	4-20 mA, DCS
LI	Cooling glycol level in main vessel in cooling unit, local indication	-	-	1	local
LI	Hot water level in vessel, local indication	-	-	1	local
SIC	Adjustment of liquid CO <sub>2</sub> pump speed, indication and registration			1	4-20 mA, DCS
SIC	Adjustment of entrainer pump speed, indication and registration			1	4-20 mA, DCS


## 12. Piping

Complete stainless steel piping system for the assembling of elements described above. Screw than welded joints are preferable. Piping system should include armatures and instrumentation.

Design data: 1 200 bar, 100 °C for the high pressure section.

## 13. Electric

Complete electrical equipment for the elements above. Switch boards, contactors and security devices should be complete wired.

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## 14. Additional equipment

Spare parts for 2 years plant exploitation

## 15. Documentation in Polish or English

### 15.1. *Process Engineering*, including

- Process flow diagrams
- Process description
- Heat and material balances
- Sizing of equipment, equipment data sheets and equipment list
- Utility requirements
- Plant operating and safety manual including start up and shut-down procedures
- Heating and cooling duties and performance specifications for heating and cooling system

### 15.2. *Piping Design*, including

- P & I diagrams
- Plant lay out
- Piping drawings (general arrangement drawings) and line list
- Piping material (material take off)
- List of insulation for piping and equipment

### 15.3. *Mechanical Engineering*, including


- Mechanical specification and description of equipment
- Equipment outline drawings
- Strength calculations
- Equipment specification list
- Operating and maintenance manuals for items of equipment
- Manufacturer's drawings control

### 15.4. *Electrical Engineering*, including

- Electrical load requirements
- Operating and maintenance manuals for items of the equipment as far as supplied
- Manufacturer's drawings control

### 15.5. *Instrumentation and Control Design*, including

- Specification of instruments and devices for process control
- Instrumentation loop and installation drawings
- Control logic
- List of all instruments and cables (material take-off)

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- Specification of the computerized control system including configuration for the operation of the extractors and the pressure equalization and recovery sequence.

**15.6. Structural Steel Design**, including

- General lay-out
- Foundation locations and loadings
- Load and force diagrams for steel structures

**15.7. Guarantee to the specified elements and equipment**

***Mechanical Warranty***

The Supplier should give a mechanical warranty for the supplied equipment for a period of min. 12 (twelve) months after start up or 18 (eighteen) months after delivery date.

***Warranty for the Engineering***

The Supplier should give warranty that the supplied engineering documentation will be complete and performed according to latest technical EU standards and free from error and omission.

**15.8. Spare parts lists**

**16. Supervision / Training**

- Supervision of erection and commissioning and start up
- Training (2 persons)

**17. Shipment**

Transport of the components and documentation - DDU INS Pulawy - on Supplier cost.

**18. Testing**

The components of the high pressure pilot plant (all equipment) should be tested under operating conditions under Supplier supervision and with Supplier cooperation. Testing shall confirm the compliance with the requirements specified in the Specification. The protocol of receipt shall be signed by the Parties in order to confirm the receipt of the object of the Contract.