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Annex C – Technical Data Sheet of the requested product

"*Cod. 63_18 – OPEN PROCEDURE FOR THE SUPPLY, TEST AND INSTALLATION OF A BIOLOGICAL REACTOR FOR CO_2 METHANATION*"

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Technical description

INTRODUCTION

Sardegna Ricerche within the "Complex project: Smart grid for efficient energy management" is going to purchase a biological reactor for CO_2 methanation.

The system must allow the conversion of carbon dioxide into methane through the biologically catalyzed, reaction with (hydrogen, it must be able to be installed inside a laboratory that has a surface of about 60 m^2 and a height of about 7 m and it must be equipped with appropriate piping for conveying the gases outside the building. The system, as a whole, must be able to work with flammable and explosive gases such as Methane and Hydrogen and must allow operation in the safety conditions required by the regulations in force in Italy.

All the equipment installed inside the reactor must have the necessary requirements for operation in the ATEX environment.

All the equipment that make up the system (reactor, control unit, service tanks, connecting pipes between them) must be mounted on a single skid that must be assembled inside the same laboratory that is equipped with doors of useful width and height equal to 120 cm and 220 cm respectively.

Within the reactor, cultures with thermophilic methanogenic bacteria must be produced with a maximum process temperature of 70 ° C, with pH values between 6.00 and 8.00 and culture times of several weeks.

A microbiological safety level of at least S1 must be guaranteed.

1. OBJECT OF THE PROCEDURE

The object of the procedure is the **supply, test and installation** of a biological reactor for CO_2 methanation.

The system must be **transported** and **unloaded free** at destination Z.I. Macchiareddu, VI Strada Ovest – 09010 UTA (CA), Italy according to the indications given by Sardegna Ricerche's staff. The system must be further **installed** in accordance with all the best practices and all the necessary connections (electric energy, water, gas line, Ethernet connection etc.) have to be realized.

2. MINIMUN TECHNICAL REQUIREMENTS

The following table shows the minimum technical requirements of the supply.

COMPONENT	DESCRPTION
Reactor	
Installation	The reactor must be installed inside a prebuilt box and connected to the outside with an appropriate aspiration system equipped with an explosion-proof engine installed outside the room that houses the reactor itself.
Type	The reactor must be of bubble column type and the mixing must be ensured by the introduction of the reacting gases (Carbon Dioxide and Hydrogen).
Operation mode	The reactor must be able to operate in discontinuous (batch) or continuous mode.
Construction	The reactor with all its parts must be completely built in stainless steel AISI 316 L and mounted on load cells connected to the supervision system.

Volume	The total volume of the reactor must not be less than 60 l, while the working volume must not be less than 50 l.
Height/diameter ratio	The diameter height ratio must not be less than 5: 1.
Internal/external finish	The internal and external finish of the reactor must be made of electro-clean steel with a roughness Ra <0.8 µm.
Insulation	It must be made of insulating material with a maximum K of 0.03 and applied to the whole reactor, including the bottom.
Design conditions	The reactor and the heating jacket must be designed to reach a temperature of 150 ° C and a pressure of between -1 and 6 barg.
Gas supply	The reactor must be supplied with hydrogen and carbon dioxide contained in high pressure cylinders. Must be provided the flow meters must be measure the flow rate of the gases entering the reactor. The hydrogen flow meter scale should be between 0 l / min and 25 l / min, while the carbon dioxide scale should be between 0 l / min and 10 l / min.
Injecting gases system (*sparging*)	Flowing from reactor's bottom through a perforated diffuser with holes diameter of 1.5 mm. Two other perforated diffusers with holes of 1 and 2 mm diameter respectively must also be provided.
Reactor heating system	It must be realized by the circulation of a suitable fluid inside a gap around the reactor.
Sealing system	Double mechanical closure or other system able to guarantee gas tightness.
Reactor cleaning	The reactor must be powered with hydrogen and carbon dioxide contained in high pressure cylinders. The flow meters required to measure the flow rate of the gases entering the reactor must be provided.
Foam breaking system	Mechanical foam breaking system.
Explosion protection (ATEX)	The whole system must be designed to guarantee operation in explosion-proof conditions **(ATEX)**.
Safety against overpressure	The reactor must be equipped with a suitable safety valve.
Internal view to the reactor	The reactor must be equipped with a speculum, with an external cleaning system and an internal optical fiber vision system.
Working pressure range	-1 – +6 barg

Sampling devices	The reactor must be provided with a device for liquid sampling inside it and mounted on the reactor body and with a device for sampling the mixture of gas leaving the reactor.
Sterilization	The reactor and all its components must be sterilized in a chemically closed circuit or by suitable heat treatment (T> 121 ° C). The sterilization circuit must comprise the reactor, the nutrient supply tank and the feed pump of the culture media.
Cultivation medium feeding pump	Dosing pump must be able to overcome the internal pressure of the reactor and operate therefore at least up to 6 barg and equipped with speed control and flow regulation, with the possibility of operation in manual or automatic mode.
pH feeding pump	Dosing pump must be able to overcome the internal pressure of the reactor and operate therefore at least up to 6 barg and equipped with speed control and flow regulation, with the possibility of operation in manual or automatic mode.
Cultivation medium circuit	Made entirely of stainless steel AISI 316 L.
Reactor discharge device	The reactor must be able to be discharged through the same feed pump of the cultivation medium by installing a special three-way valve.
Adjustment, control and registration parameters	They must be able to be measured, adjusted and recorded continuously: Temperature, Dissolved O_2, Dissolved CO_2, pH, Mass, Pressure, Gas Flow at the Inlet of the reactor, Output Gas Flow Rate, Level. The nutrient solution flow rate and the foam level must be measured and recorded.
Sensors Installation	All the sensors must be installed on the reactor top closure device, which must be equipped with specific housings.
General characteristics of the sensors	All the sensors must have such characteristics to operate in the **ATEX** environment.
Suggested rates for different gases	H_2 50 -3000 l/day CO_2 12-750 l/day
Exiting gases treatment	
Dehumidification	
Filtration	
Cultivation medium preparation reservoir	Made entirely of stainless steel AISI 316 L and connected to the reactor with the necessary pipes,

	valves and fittings. The volume must not be less than 50 l.
Reactor emptying tank	Made entirely of stainless steel AISI 316 L and connected to the reactor with the necessary pipes, valves and fittings. The volume must not be less than 100 l.
Supervision and control system	
PLC	The supervision and control system, based on a logic control programmer (PLC), must allow the remote operation of the entire system and all its components (for example loading and unloading operations, gas injection and nutrients, etc.).
Processing data Software	The system must be equipped with specific software for continuous recording and processing of data in Excel format and all parameters chosen for reactor control. The aforementioned software must be installed on a Personal Computer that will be provided by Sardegna Ricerche.
Required performances of the supervision and control system	
Supervision	Synoptic view of the whole system Alarm configuration Display of current values of the variables Display of set points.
Calibration	The provided sensors must be equipped with: - Calibration menu for the different sensors - Storage of calibration data - Protocols containing set points, state of the actuators, configuration of the control cycles.
Control cycles	Control cycles for variables: temperature, mass inside the reactor, pressure, pH, CO_2, O2, flow rates, level, nutrient dosing.
Logical sequences programming	The system must allow the operator to create and use specific logical sequences (nutrient feeding, pH regulation, etc.).
Viewing and recording data	It must be possible to view in real time the trends of all the parameters measured by the sensors with the possibility of expansion up to 20. The data must also be able to be recorded continuously and easily exported to external media.
Laboratory utilities	Air 8 bar Water 4 bar

	220 V single-phase electric current Hydrogen lines Carbon Dioxide Lines
Materials and reactor suitability	The relative documentation must be provided to Sardegna Ricerche.
Instruments certificates for calibration	Calibration certificates and relative use and maintenance manuals must accompany all the measuring instruments supplied.
User and maintenance manual	A user and maintenance manual must be provided with a detailed description of the system in all its parts. The drawings, the P & I, and everything else necessary to accurately identify the whole system must also be delivered.
Functionality test	The functionality test will be performed by the supplier company with the presence and support of the personnel made available by Sardegna Ricerche. The test must be performed under the real operating conditions. Sardegna Ricerche will provide all the materials necessary for the operation of the system.
List of spare parts	The list of all necessary spare parts must be provided.
Transport	Cost included in the offer.
Installation internal connections and connections to the utilities of the complete system	The winning company will make the internal connections, the connections of the machine complete system to the utilities, necessary for the execution of the tests of testing and operation with its own personnel.
Staff training	A training course for personnel must be provided with the cost included in the offer.
Warranty period	Not less than 12 months.

3. INSTALLATION SITE

It is specified that the entire system must be assembled within a laboratory that has a surface of approximately 60 m^2 and a height of about 7 m and must be equipped with appropriate piping for conveying the gases outside the building, which has openings of useful width and height of 120 cm and 220 cm respectively.

4. TIME FOR SUPPLY AND INSTALLATION

It is specified that the delivery, assembly and testing of the biological methanation machine must be completed no later than 10 months from the date of the order.

5. NOTES

It is also requested to include in the supply:
- all the activities and operations needed for the correct execution of the service in compliance with the law requirements;

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- all additional burden for installation and connections of the proposed system, connection to the grid, tests, start-up, operational checks and anything else necessary for the delivery of the fully functional system (necessary support structures, monitoring and control system, protections...);
- all the burden necessary to guarantee the proper functionality of the system in compliance with current regulations and with the technical offer;
- all direct and indirect costs associated with on-site training courses and assistance and maintenance services;
- all charges related to the disposal of any waste produced during the delivery, installation and commissioning of the system;
- expenses connected with the signing of contract and activation of final deposit;
– all the burden related to the costs of legal publication of the call for tenders.

All the machinery and work equipment that will be used by workers during the installation must fulfill all the specific legislative requirements, be suitable for the activities to be carried out, guarantee the health and safety conditions to the workers and be adequate for the work to be performed.

Sardegna Ricerche will verify the correct execution of the service and the full respect of what is reported in the present technical sheet. The positive outcome of the verification of the service execution is essential for the conclusion of the payment. The service must be carried out in a professional manner and without damaging the components of the system. The economic operator shall be jointly and severally liable for any damage caused to the goods during the performance of the service for a maximum amount equal to the value invoiced Sardegna Ricerche for the purchase of the equipment itself.