Cryogenic Supply System (CSS)

ABOUT CYCLOMED TECHNOLOGIES

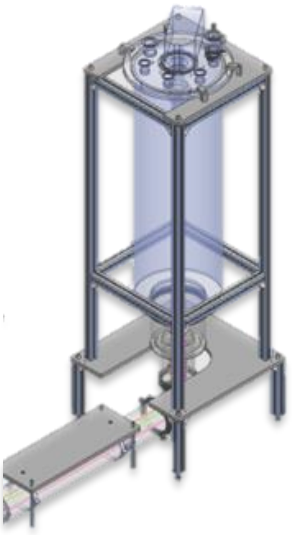
CYCLOMED Technologies is a Spanish deeptech company expert in superconductivity and cryogenics applied to the health sector. CYCLOMED has developed a cyclotron-type particle accelerator that makes it possible to produce short-lived PET isotopes such as Carbon-11 or Fluorine-18. This allows to expand PET scan tracer alternatives for nuclear medicine imaging.

CRYOGENIC TECHNOLOGY

The cryogenic supply system is based on a closed loop forced-flow refrigeration configuration, where certain amount of cryogen is cooled down and it is pumped into the final user application to achieve the desired temperature.

The helium is pumped into the circuit at ambient temperature and it passes through a series of heat exchangers and a cryocooler where it is cooled down. The system provides refrigeration for two circuits, the final application, typically a magnet, and a thermal shield.

The core of the CSS is a Sumitomo cryocooler that could be modified (increasing the number or the type of cryocooler) depending on the thermal requirements of the final application.



Helium Free

No consumption of liquid helium. The system is based on the recirculation of helium gas.

Remote cooling

Capable of providing liquid helium at a distance of 2 meters, with low thermal losses.

Easy Maintenance

The cryogenic supply system could be intervened without affecting the user's application.

Operating safety

Operating at a distance the system is safe from vibrations, magnetic fields, or component activation.

APPLICATIONS

Health sector: For MRI and NMR systems that still relies on liquid helium to operate. The CSS could be a cheap alternative to substitute this expensive and scarce element.

Superconducting power applications: For electric machines that uses superconducting magnets that could benefit from a remote cooling. Applications that could profit from the separation of the magnetic and cooling system and require high operational safety and low maintenance.

R&D: R&D applications that could use an autonomous cooling system with scalable power for the construction of prototypes and design of experiments.

CHARACTERISTICS

General (Specifics for use case: Patent: ES2436010A1)	
Weight	200 kg
System size (l x w x h)	0.6x0.6x2 m
Power consumption	~15 kW
Ambient conditions	5-35 ºC 10 % - 95% humidity
Cooling water supply	1500 l/hr (20% glycol)
Cooling characteristics	
Working pressure	Up to 5 bars
Mass flow	Depending on user application
Heat capacity	Depending on user application

CYCLOMED
Antonio Cavero, 93
28043 Madrid
Email: cyclomed@cyclomed.tech
Web: cyclomed.tech

USE CASE: SUPERCONDUCTING CYCLOTRON (Patent: ES2436010A1)

The patent ES2436010A1 consist on a classical compact superconducting cyclotron with weak focus fundamentally oriented to the production of isotopes. The magnetic system comprises of a 4T superconducting magnet of NbTi, that requires an operating temperature lower than 6K. Four possible cooling system configurations were identified: a bath-type refrigeration (the superconducting magnet is immersed in a liquid helium bath), conductive refrigeration (cryocooler in contact with the superconducting magnet), hybrid configuration (magnet immerse in a cooling bath with a cryocooler that cools down the evaporate helium) and a forced-flow configuration with the CSS. The advantages and disadvantages of each configuration are considered.

	Bath-Type	Conductive	Hybrid	CSS
Advantages	✓ Simple ✓ Highly reliable ✓ Isothermal refrigeration	✓ Simple ✓ Low operational cost	✓ Reliable ✓ Low operational cost ✓ Isothermal refrigeration	✓ Autonomous system ✓ Separate system designs ✓ Scalable power ✓ Easy maintenance ✓ High operational safety ✓ Low operational cost ✓ Isothermal refrigeration
Disadvantages	× Expensive (scarce element), periodic refillments × High operational cost	× Magnetic and cooling system design linked × Difficult maintenance × Component activation × Fixed thermal power	× Magnetic and cooling system design linked × Difficult maintenance × Component activation × Fixed thermal power	× Complex system × Higher initial cost

For autonomous, cheap and compact radioisotope production facility, a closed cycle cryogenic system was selected, in order to eliminate the need of periodic refills or the construction of a large cryogenic system.

The development and design of the system was done in collaboration with CERN. The CSS is an assembly of heat exchangers, heaters and temperature sensors that receives two inlets of gas Helium (ambient temperature and cold gases). It cools them down to first and second stage temperatures of the cryocooler, respectively. These two circuits are used to cool the thermal shield (first stage) and the superconducting magnet of the cyclotron (second stage). Once the steady state is reached, the latter one will become liquid Helium.

Technical specifications

Cooling characteristics			
Working pressure	2-3 bars	**First stage nominal power and temperature**	1.4 W at 4.5 K
Mass flow	6-10 g/min	**Second stage nominal power and temperature**	25 W at 40 K

CYCLOMED
Antonio Cavero, 93
28043 Madrid
Email: cyclomed@cyclomed.tech
Web: cyclomed.tech