Stirling Closed Loop Cooling Systems

Providing cooling power from 18 to 150K

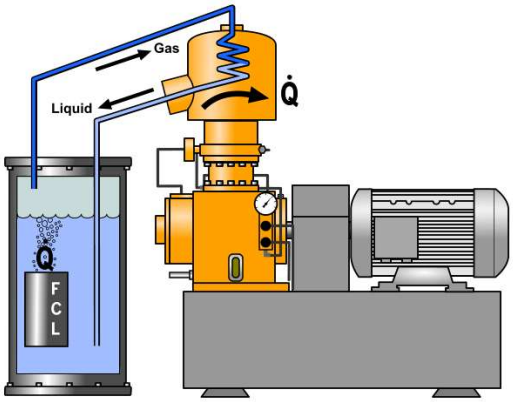
Stirling Cryogenerators

Stirling Cryogenerators have been developed in the 1960's and since been used in a wide variety of applications, ranging from on-site production of LN_2 for universities and artificial insemination, to cooling of superconducting devices and research instruments.

Thanks to the Cryogenerators being available in many different variations of cold heat-exchangers, Stirling's cryogenic systems can likely be adapted to the requirements of the application to be cooled. Cryogenic gases can be (re-)liquefied directly in the cold heat-exchanger causing a phase change, or a liquid or gas flow can be cooled for applications requiring a mono-phase flow.

Re-liquefaction Loops

These are generally used when the application is situated in a bath of cryogenic liquid, usually LN_2 or LNe. Heat of the application boils the liquid, the gas being fed to the Cryogenerator which removes the heat by re-liquefaction. Examples are superconducting Fault Current Limiters or large devices like neutrino detectors. While in the formers ones the Cryogenerator can be directly connected to the cryostat, the latter will require a more extended system with a pump to feed the LN_2 back to the application cryostat.



Re-liquefaction LN_2 loop for a bath type application set-up

2021 Stirling Cryogenics 67K sub-cooled LN_2 cable cooling system
Courtesy ComEd and AMSC, USA

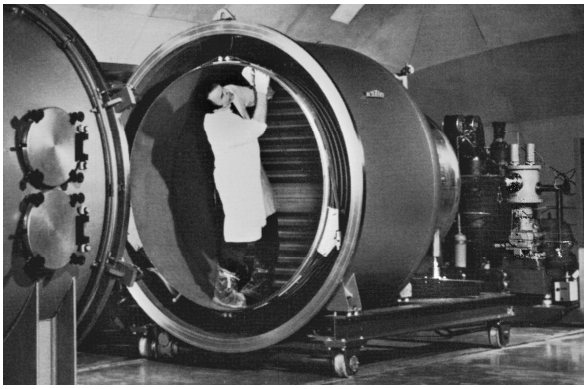
Mono-phase Liquid Loops

For applications in which boiling is not allowed, Stirling Cryogenics can provide a closed loop system that supplies a sub-cooled LN_2 flow. This will remove heat from the application by warming up a few degrees while remaining liquid. This is of importance for e.g. superconducting cables in which a two-phase flow will not have sufficient heat transfer coefficient and shall thus be avoided. Example is the Stirling system provided to ComEd in Chicago, cooling a superconducting cable down to 67 K.

Cold He Gas Loops

For temperatures from 150 down to 20K, a flow of cold helium gas can be used to thermally connect a Cryogenerator with an application. This will be required in case the application is at some distance, has a large surface or that has an internal heat-exchanger. Examples are cooling of shielding in vacuum chambers, re-liquefaction of hydrogen or methane inside a storage vessel and superconducting DC cables.

2019 Stirling Cryogenics Hydrogen Re-liquefier for Cold Neutron Source at RID
Photo Courtesy Reactor Institute Delft, The Netherlands

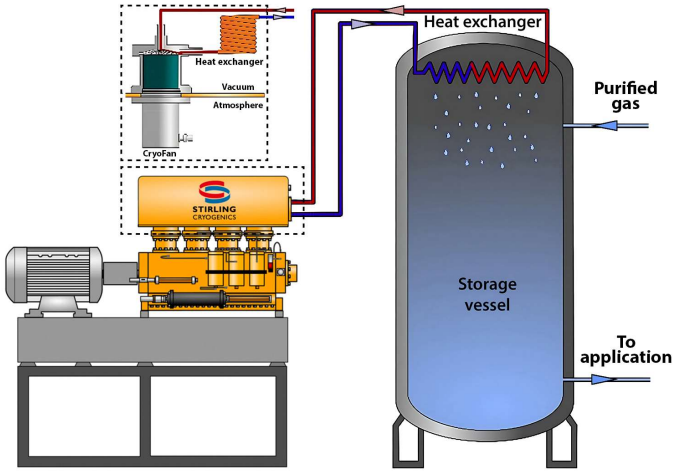


SPC-1T two-stage Stirling Cryogenerator using two CryoFans, cooling vacuum chamber shields at 20 and 80K, around 1969

To circulate such helium flow, Stirling Cryogenics has developed a range of so called CryoFans for flows from 0.1 to 45 m^3/h and a larger range from 300 to 450 m^3/h. The CryoFan design is for a maximum static pressure of 30 barg and temperatures down to 15K. To avoid any rotational seals, the high-speed motor is placed inside of the pressure hull, however works at ambient temperature being connected to the impeller via an elongated shaft.

The CryoFans are usually integrated in the Stirling Cryogenerator, but can also be placed in the customer's cryostat.

Stirling CryoFans



An example is the OYSTER project at the Reactor Institute in Delft, at which a Stirling He loop cools the LH_2 bath of a neutron moderator inside the reactor core.