

BASIC THERMODYNAMICAL CYCLES FOR HELIUM REFRIGERATION

by Guy GISTAU BAGUER

What for?

This short course is intended to make beginners understand cryogenic refrigeration thermodynamical cycles; it is not intended to teach how to design cryogenic systems.

How?

The main guideline of the courses is the natural thinking path that one follows when studying a problem. Difficulty and complexity go increasing with progression in the topic. Theory is limited to what is necessary to understand the processes that are introduced and discussed in the course. *It is not intended to teach Thermodynamics.* Only a few equations are displayed. The goal is to make people "feel" the operation of machines; for that, in the basic cycle presentations about refrigeration, emphasis is put on energy circulation in the systems.

The course is given through "animated" Microsoft PowerPoint® and Excel® presentations. Here, the goal is to make people follow explanations in a comfortable way: the presentation displays information at the same rate as oral explanations, as if the orator were drawing on a black board (see *Advances in Cryogenic Engineering, Vol. 49A, CEC 2003, Anchorage, pages: 101 to 110*). The Excel® animated presentations allow making "live" calculations on examples that are significant; for example, the way in which the exchange diagram of a heat exchanger is modified according to the operating conditions.

Whom for?

- Young engineers of course, but also people already working in the field of helium, especially operators who might never have had a complete introduction to the basics of their job.
- Any person involved in designing or building cryogenic systems.

How long?

This short course will last one full day.

Support material

All PowerPoint slides and Excel spread sheets will be delivered in an A4-size colour printed booklet (See pictures hereunder).

PROGRAM

- A general reminder (units, helium properties, heat and mass balance, heat exchangers)
- Comparing refrigeration and liquefaction operations
- Helium expansions (isenthalpic, isentropic)
- The Joule Thomson cycle; analysis
- The Brayton cycle; analysis
- The Claude cycle with one and two expanders; analysis
- Optimisation of expander temperatures
- Cycle efficiency calculation
- *Some "extras" if time available...*

Guy GISTAU BAGUER's experience:

- * conception and construction of :
 - small helium and hydrogen liquefiers and refrigerators (10 to 200 L/h),
 - large and very large helium refrigerators up to 18 kW at 4.5 K,
 - helium refrigerators from a few hundred Watts up to a few kW at temperatures < 2.0 K.
- * (re)starting-up refrigeration or liquefaction plants,
- * special experience on Cryogenic Centrifugal Compressor control for operation at temperatures < 2.0 K.

