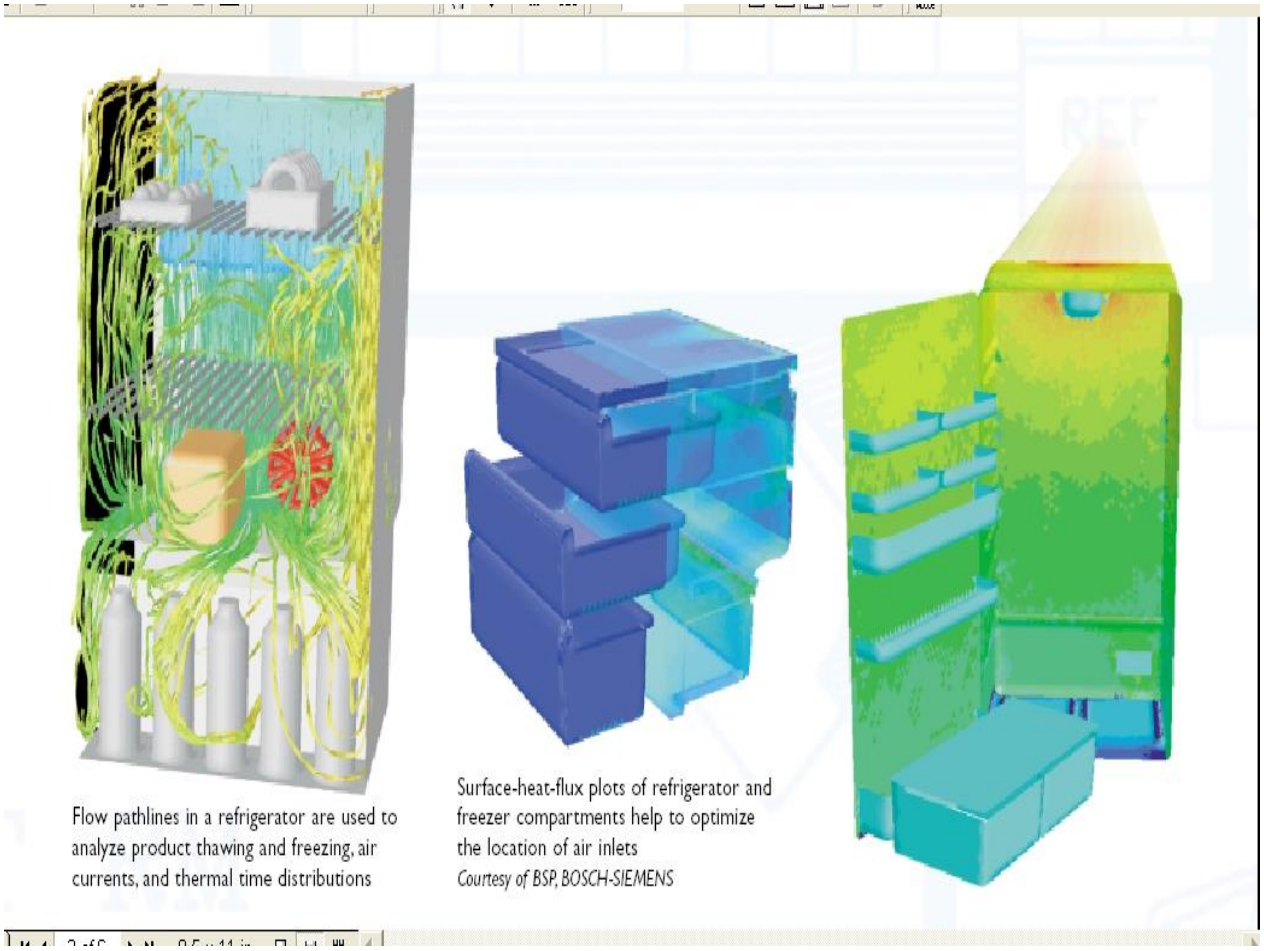
Transferência de Calor e Massa

- Conceitos
- Convecção e superfície externa
- Convecção em dutos
- Convecção natural
- Convecção com mudança de fase
- Trocadores de calor
- Transferência de massa

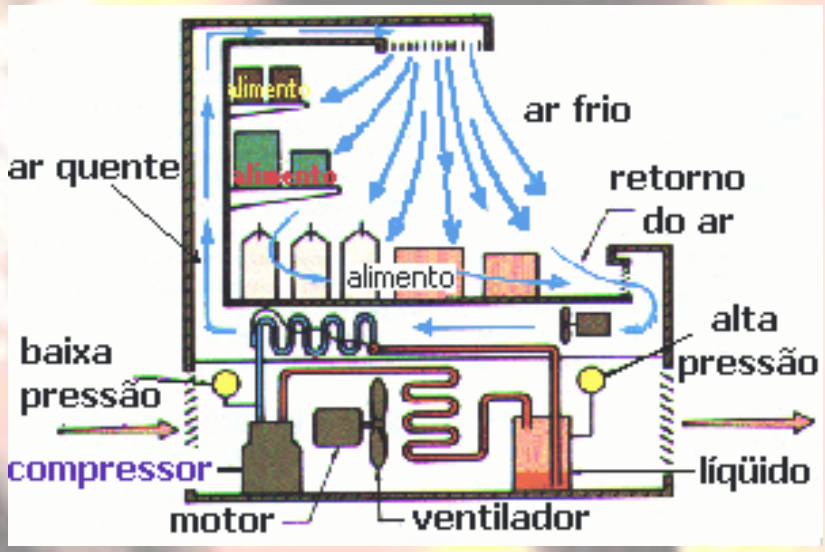
Aplicações



Flow pathlines in a refrigerator are used to analyze product thawing and freezing, air currents, and thermal time distributions

Surface-heat-flux plots of refrigerator and freezer compartments help to optimize the location of air inlets

Courtesy of BSP, BOSCH-SIEMENS

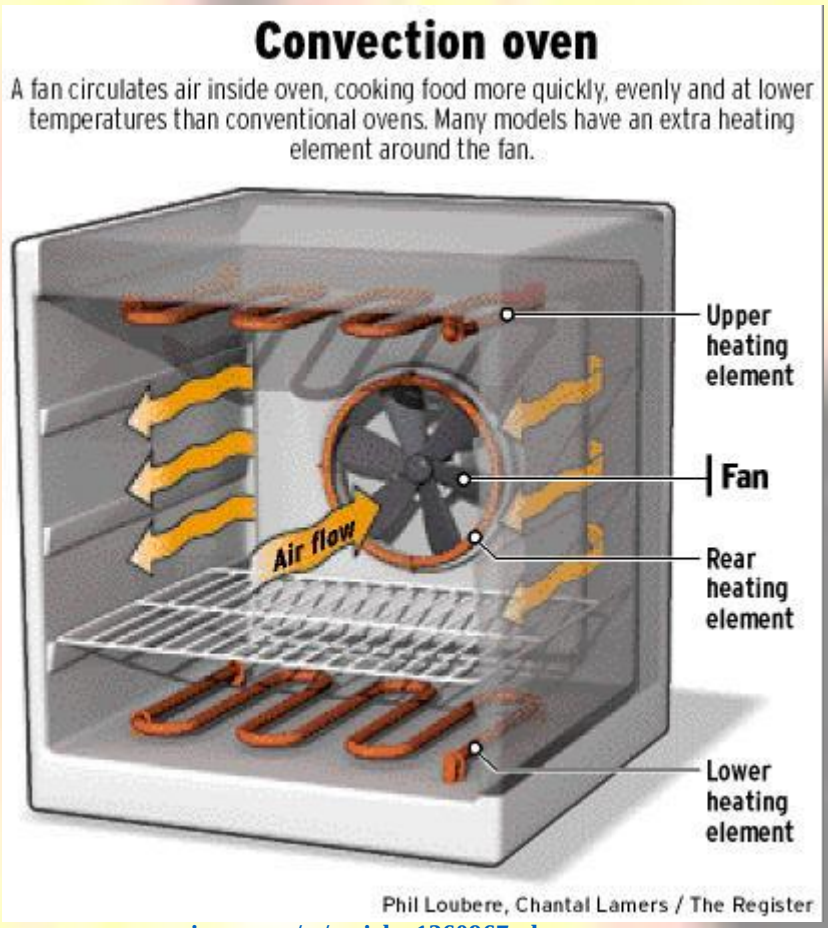


http://www.cepa.if.usp.br/energia/energia1999/Grupo2B/Calor/conveccao.gif

www.ormifrio.com.br/main_balc.htm

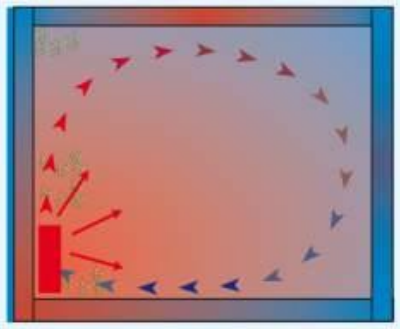
Fornos

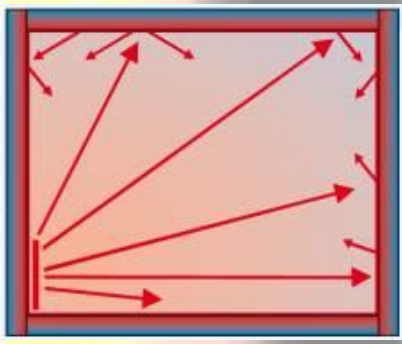
eurofood.com.br/

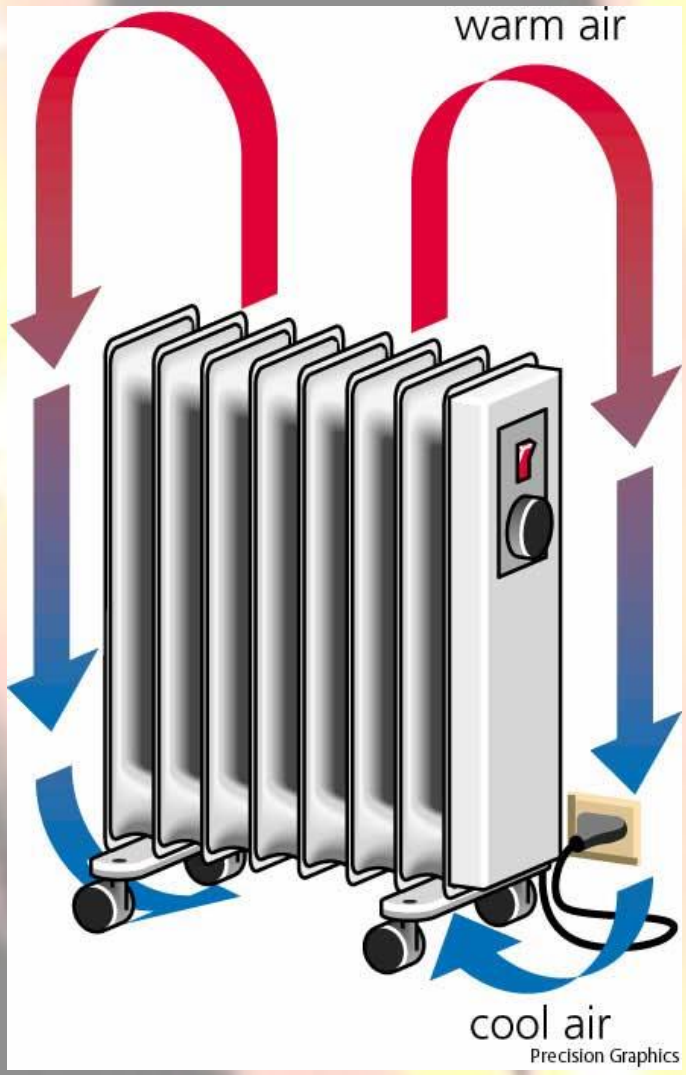


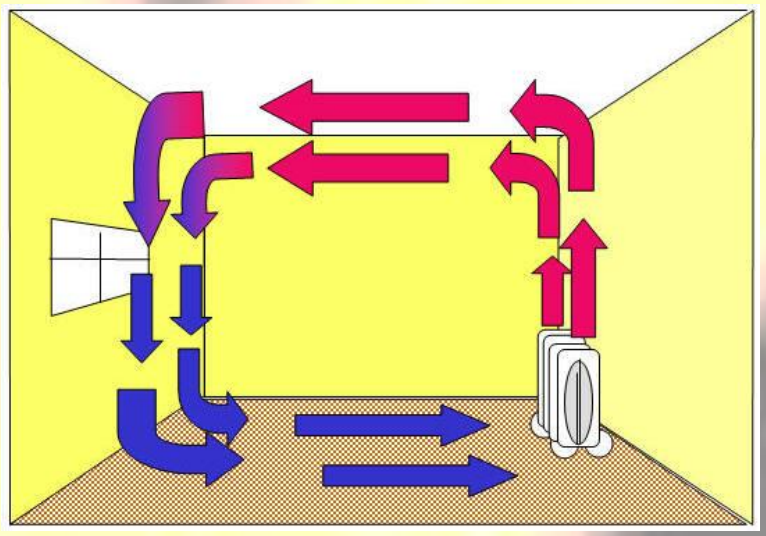
www.ocregister.com/.../article_1360967.php

Convecção natural





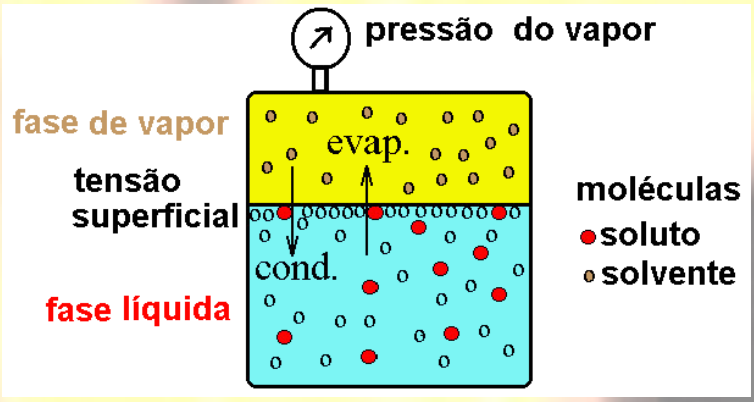


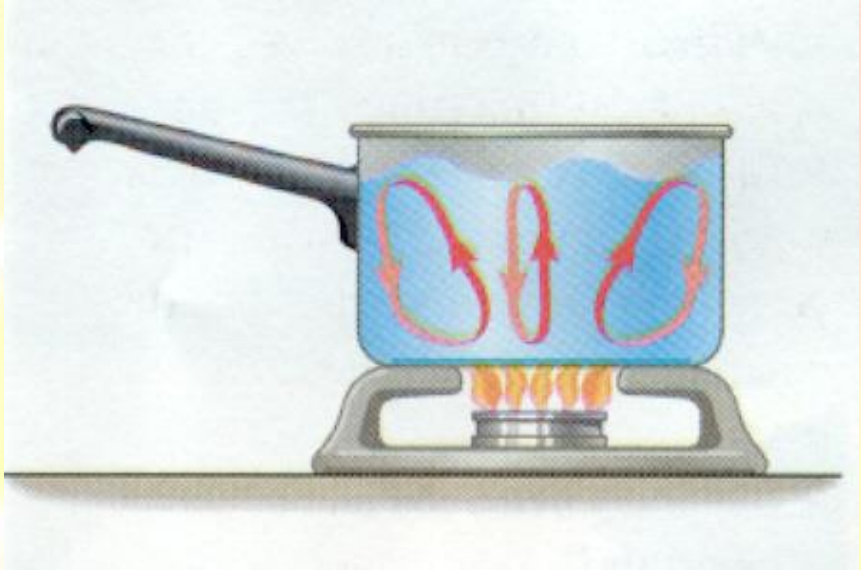


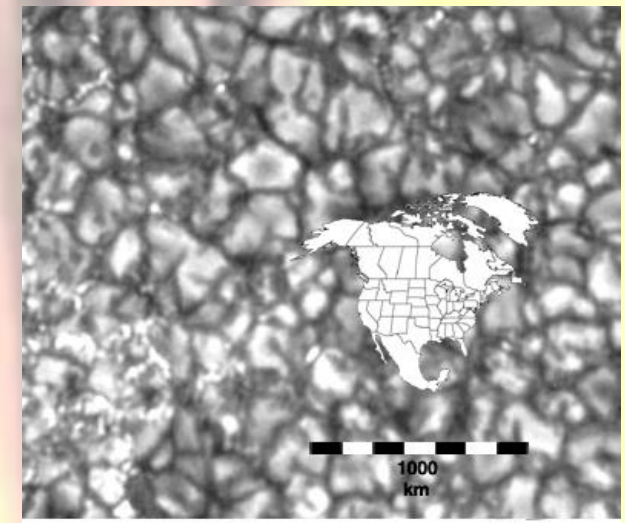
www.allrefer.com/pictures/s1/c0612500-convection

Transferência de calor e massa

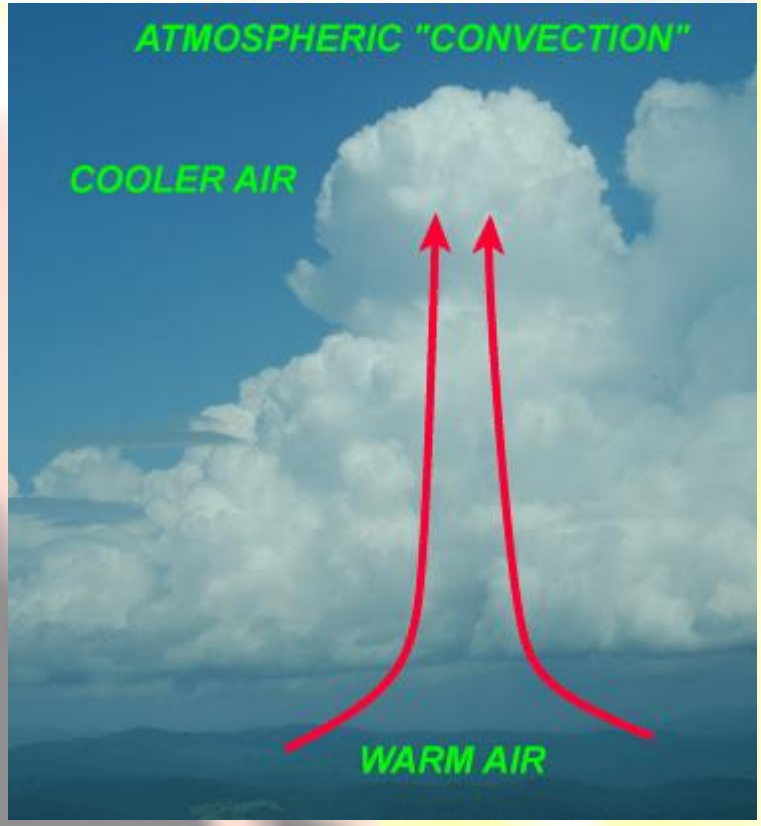
http://www.es.flinders.edu.au/~mattom/IntroOc/notes/figures/images/convection2.jpg

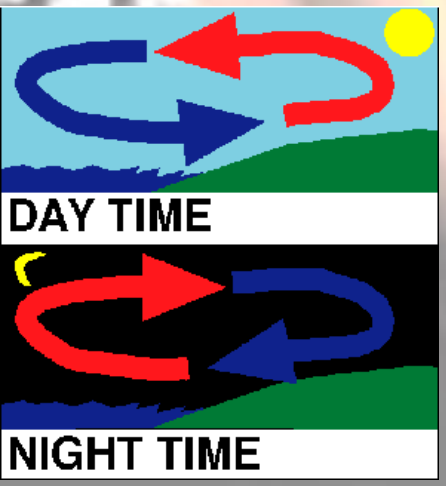


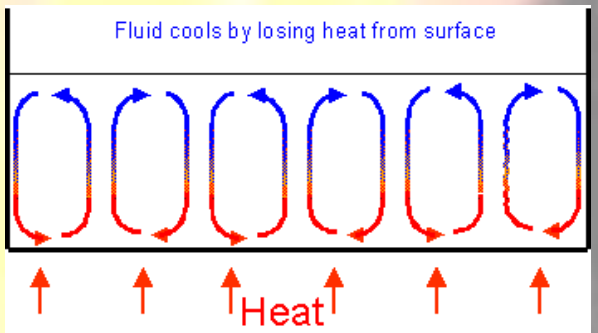




Photospheric granulation, G. Scharmer
Swedish Vacuum Solar Telescope
10 July 1997







Convection cell
Warm, low density fluid rises
Cool, high density fluid sinks

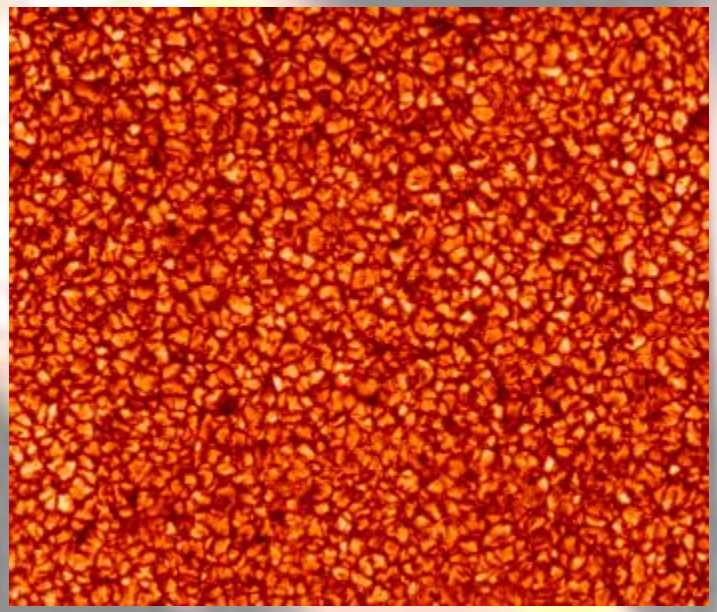
www.chemistrydaily.com/chemistry/Convection

Mudança de fase

cantinhodaciencia.no.sapo.pt/.../conveccao.htm

forum.brasilescola.com/.../index.php/t272.html

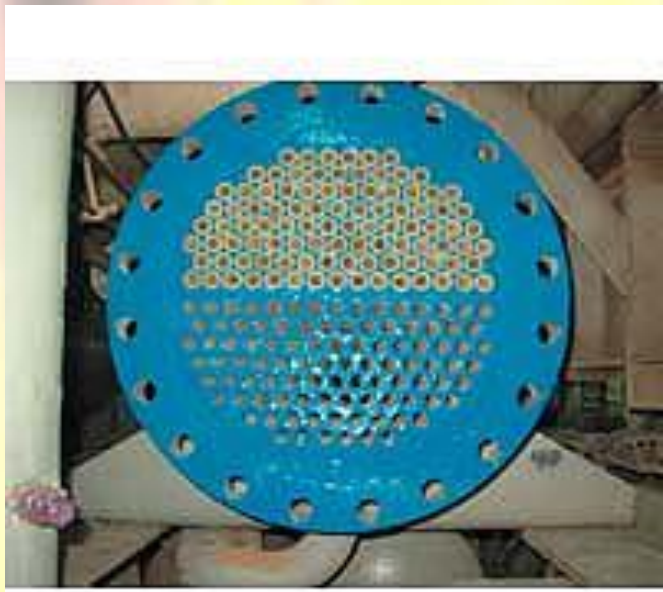
Solar Granulation (Convection) Cells

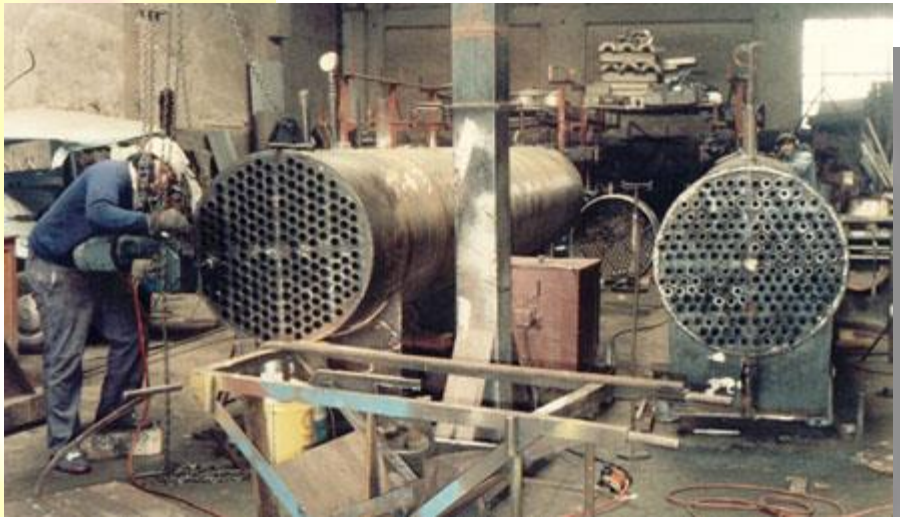


Thunderstorms near São Paulo, Brazil

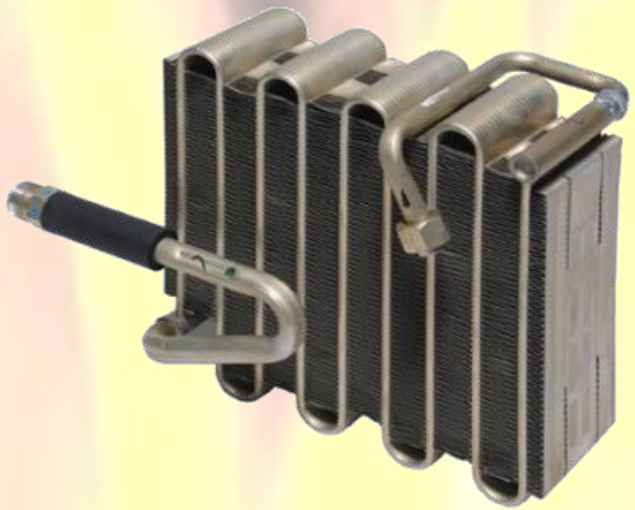
www.chabotspace.org/.../images/convection.html

Trocadores de calor



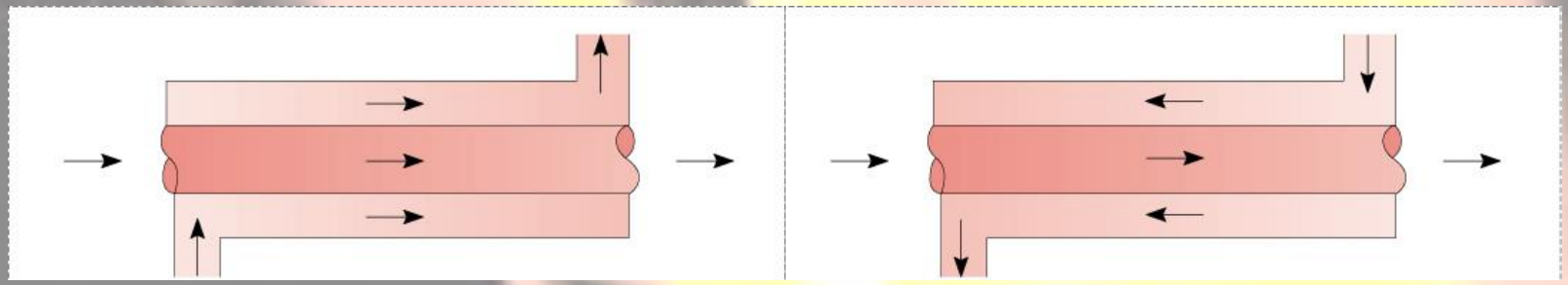


Trocadores de Calor

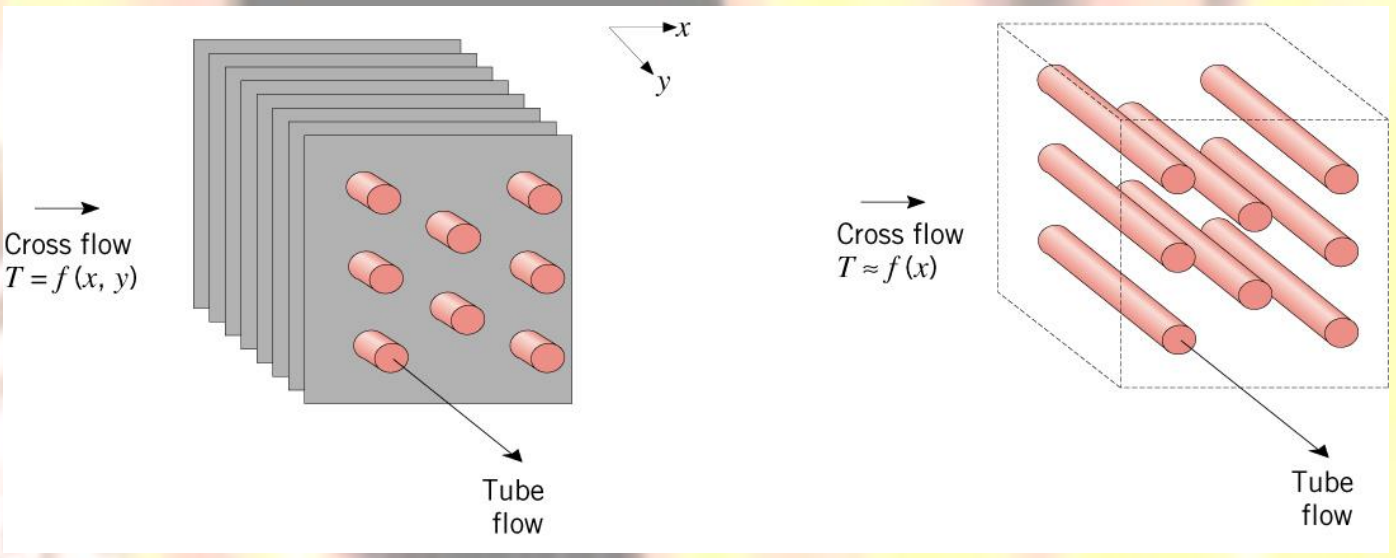


Parallel Flow

Counterflow



- Cross-flow Heat Exchangers



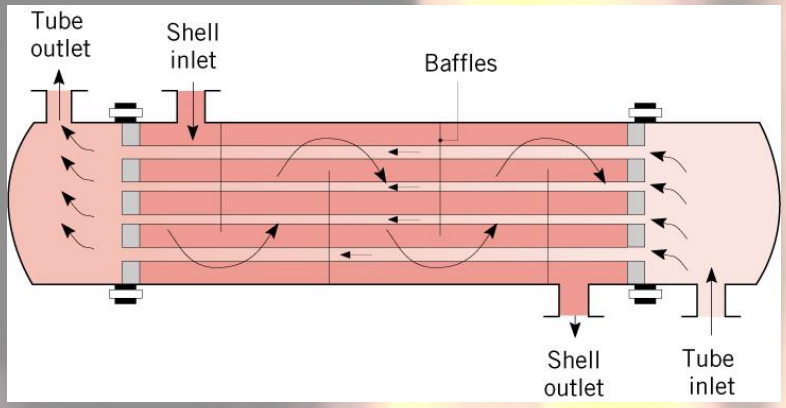
Finned-Both Fluids Unmixed

Unfinned-One Fluid Mixed the Other Unmixed

- For cross-flow over the tubes, fluid motion, and hence mixing, in the transverse direction (y) is prevented for the finned tubes, but occurs for the unfinned condition.

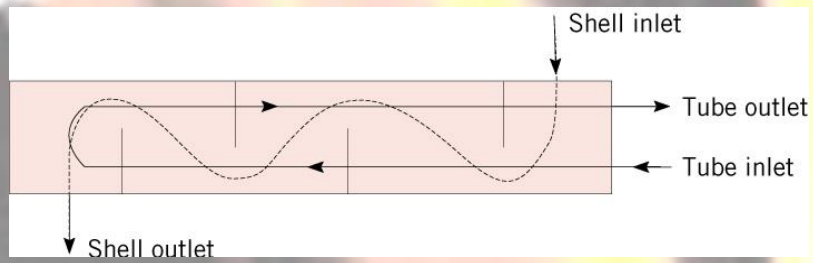
- Heat exchanger performance is influenced by mixing.

- Shell-and-Tube Heat Exchangers

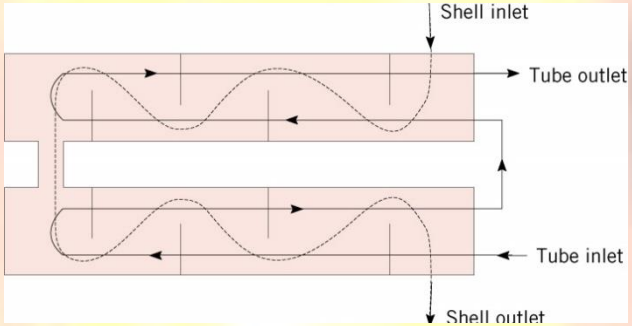


One Shell Pass and One Tube Pass

- Baffles are used to establish a cross-flow and to induce turbulent mixing of the shell-side fluid, both of which enhance convection.
- The number of tube and shell passes may be varied, e.g.:

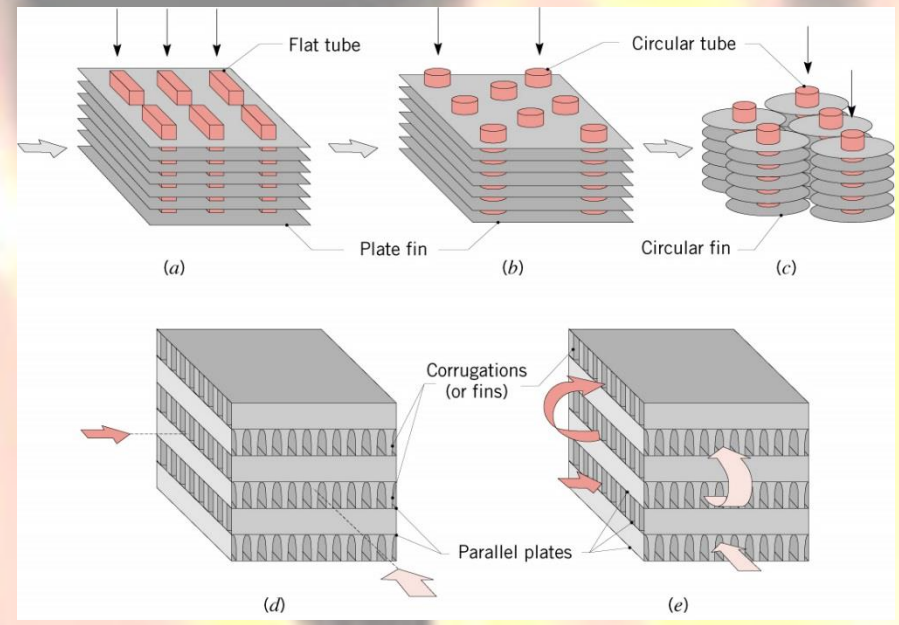


One Shell Pass,
Two Tube Passes



Two Shell Passes,
Four Tube Passes

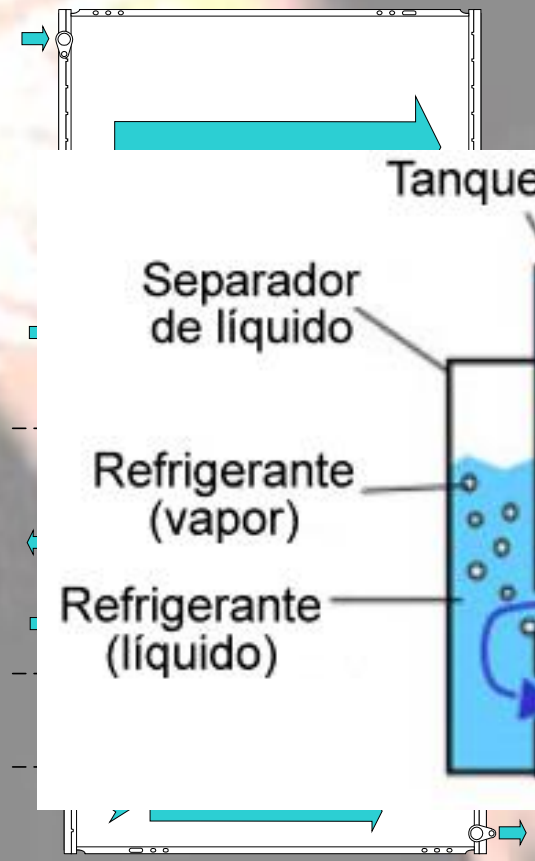
- Compact Heat Exchangers
  - Widely used to achieve large heat rates per unit volume, particularly when one or both fluids is a gas.
  - Characterized by large heat transfer surface areas per unit volume, small flow passages, and laminar flow.



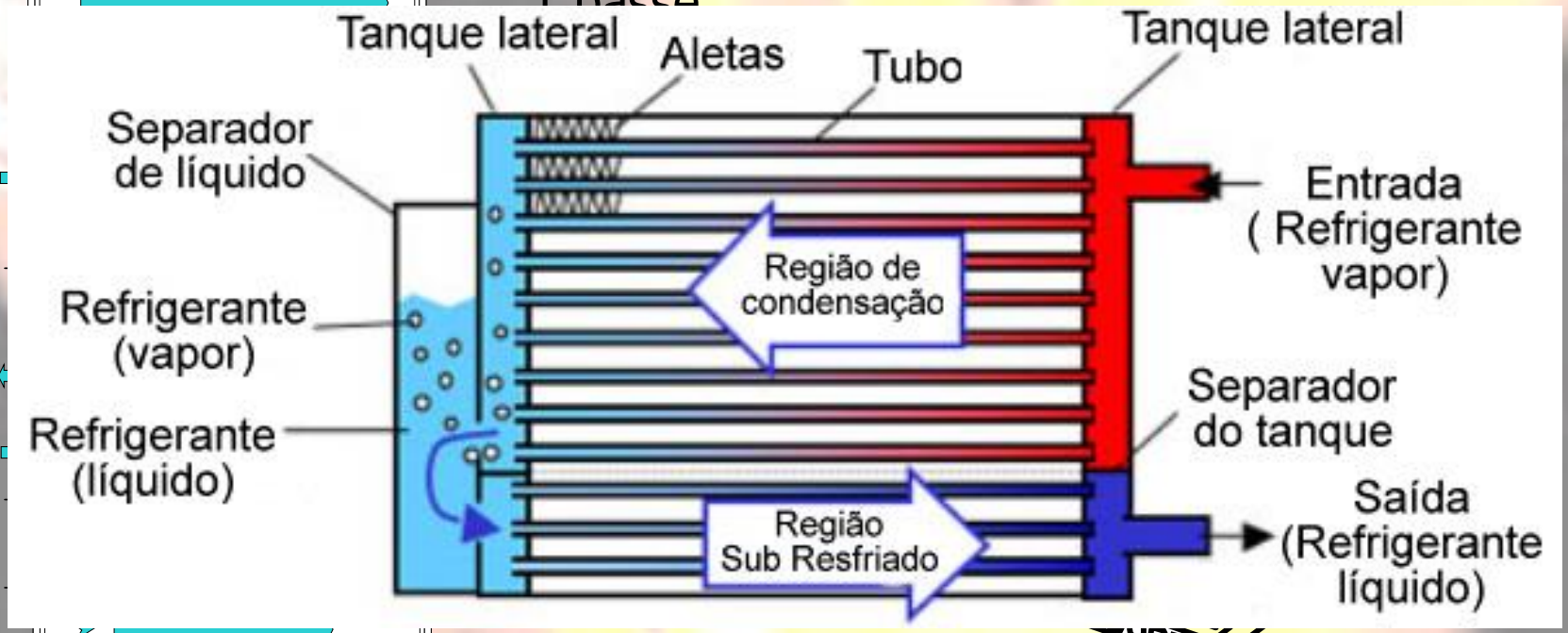
(a) Fin-tube (flat tubes, continuous plate fins)
(b) Fin-tube (circular tubes, continuous plate fins)
(c) Fin-tube (circular tubes, circular fins)
(d) Plate-fin (single pass)
(e) Plate-fin (multipass)

Condensador

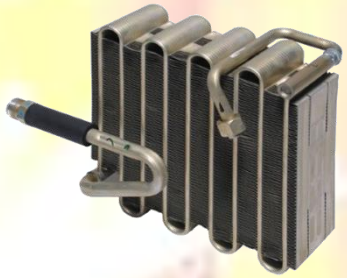
Os condensadores de fluxo paralelo surgiram melhorando ainda mais a eficiência e com peso reduzido.

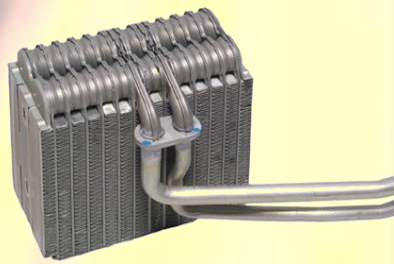


Microcanais



Sistema de sub-resfriamento

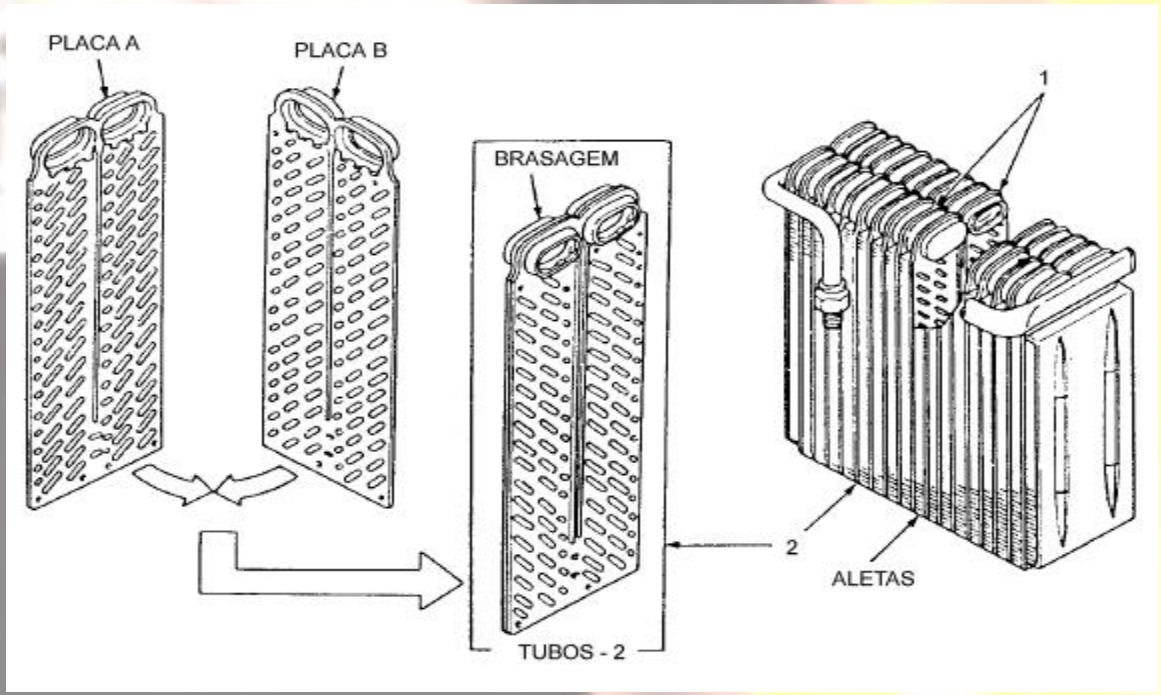




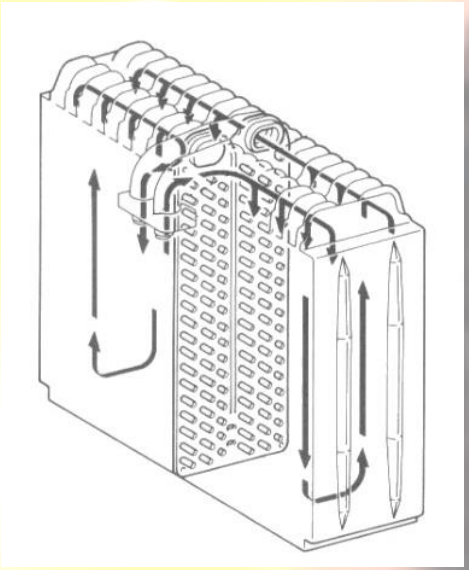
Evaporador

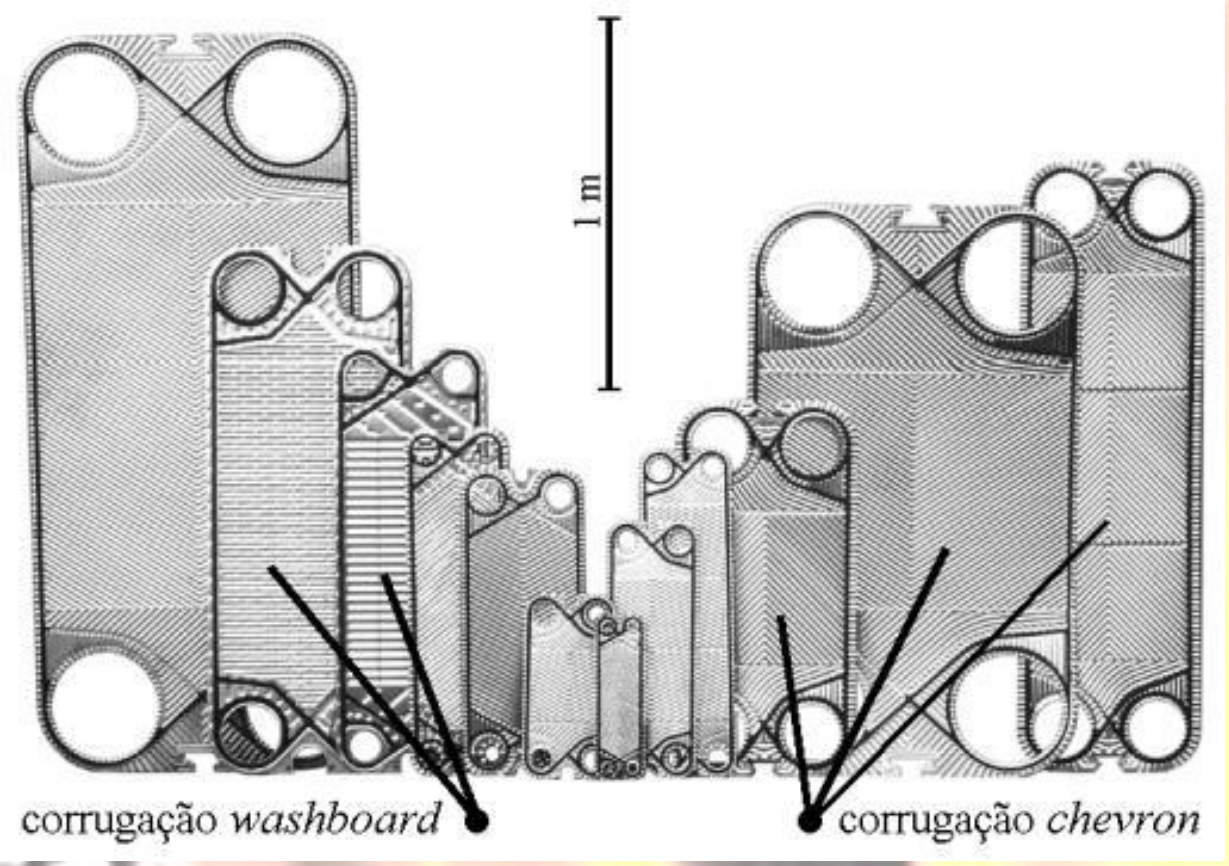
Este trocador de calor no início também era constituído de tubos circulares fixados por expansão mecânica, sendo substituído pelo modelo serpentina e depois pelo evaporador de placas.

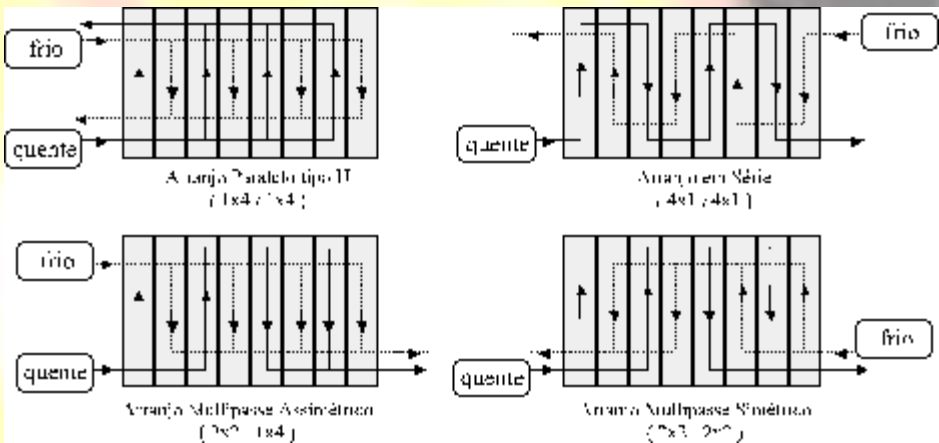
Montagem da placas



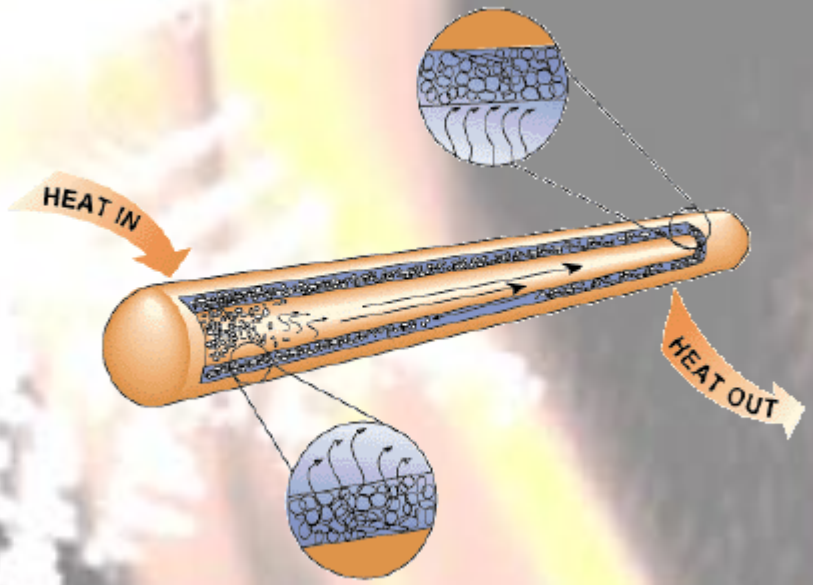
Fluxo do Gás

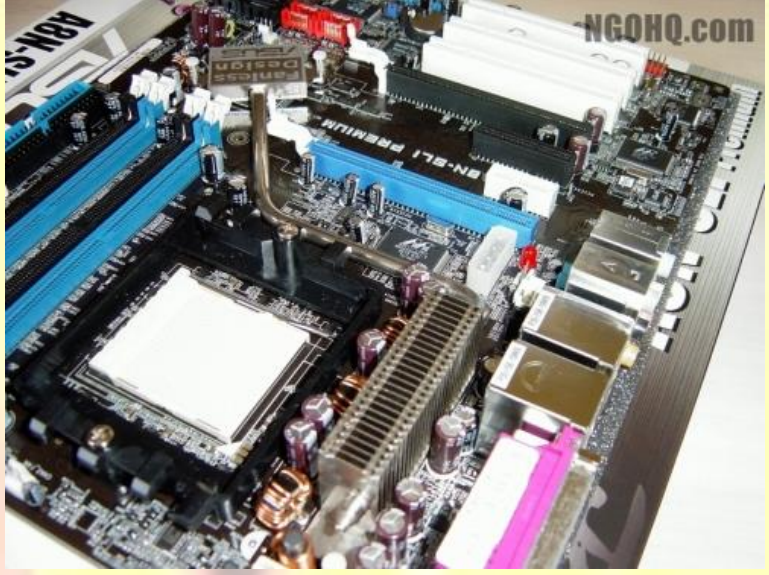



1 m
corrugação *washboard*
corrugação *chevron*

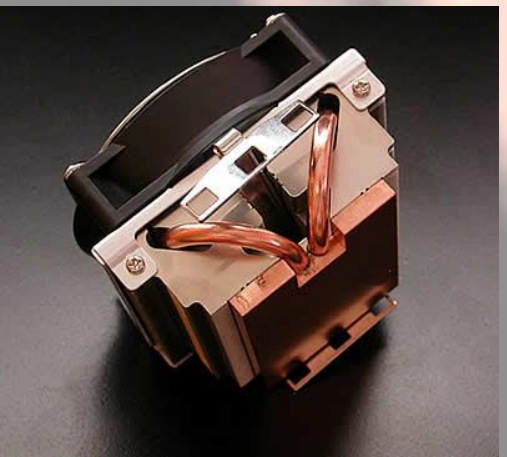

frio
quente
frio
quente
frio
quente
frio
quente

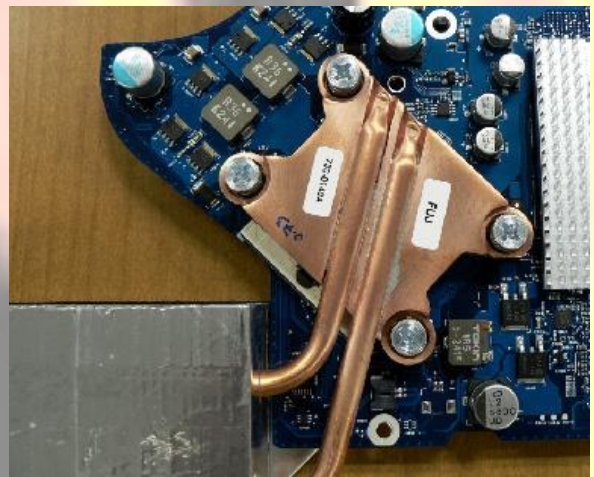
Heat pipes

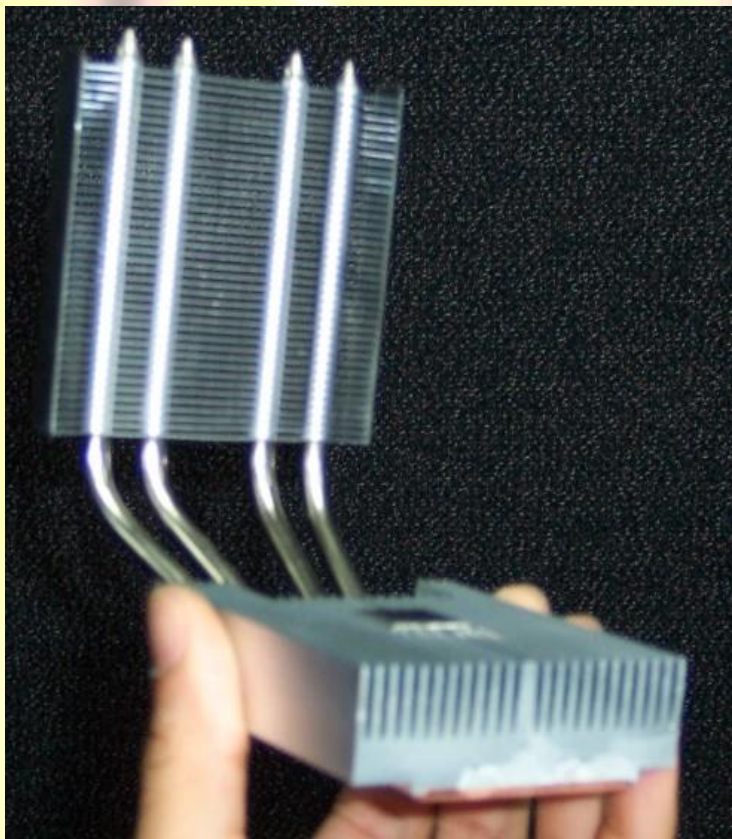


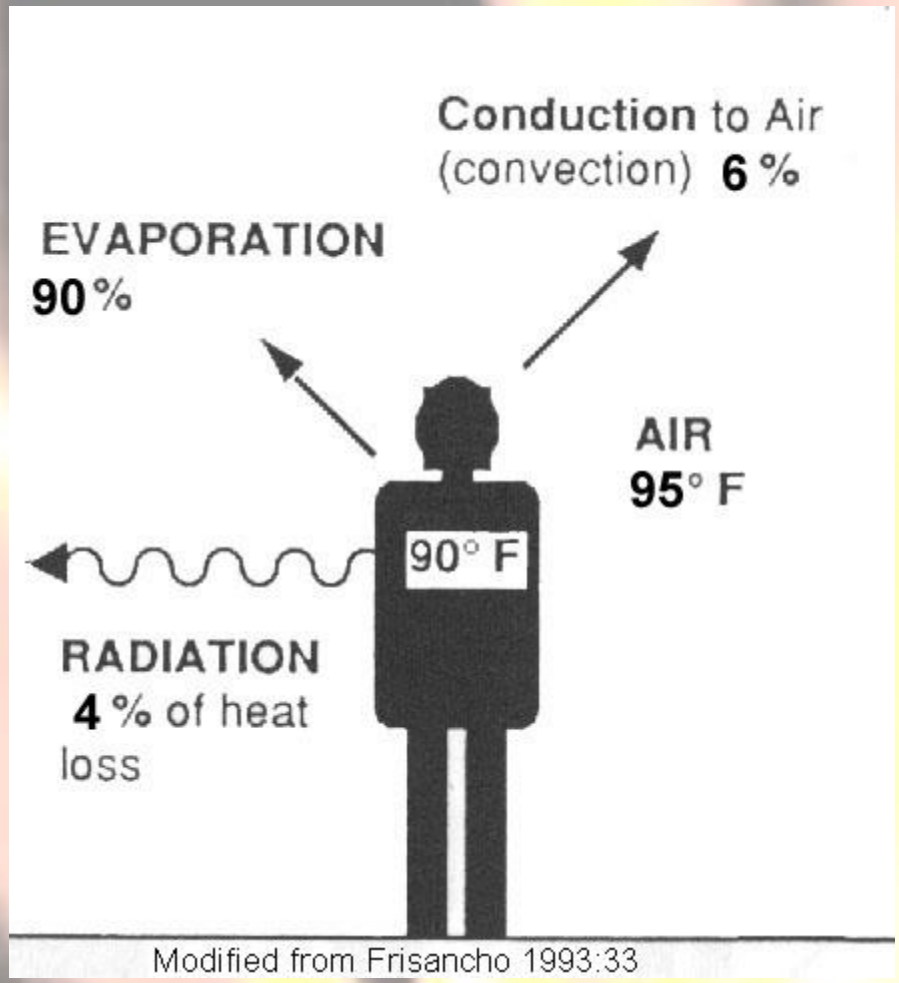


www.eng.fsu.edu/~shih/succeed-2000/roadmap/en...



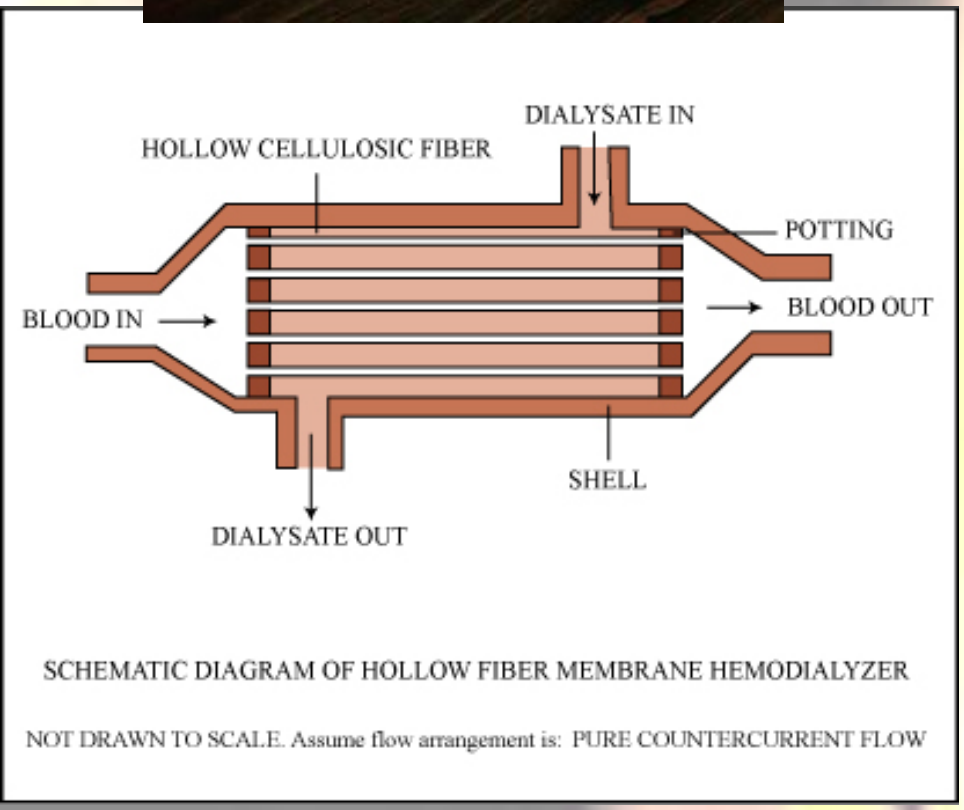






Modified from Frisancho 1993:33

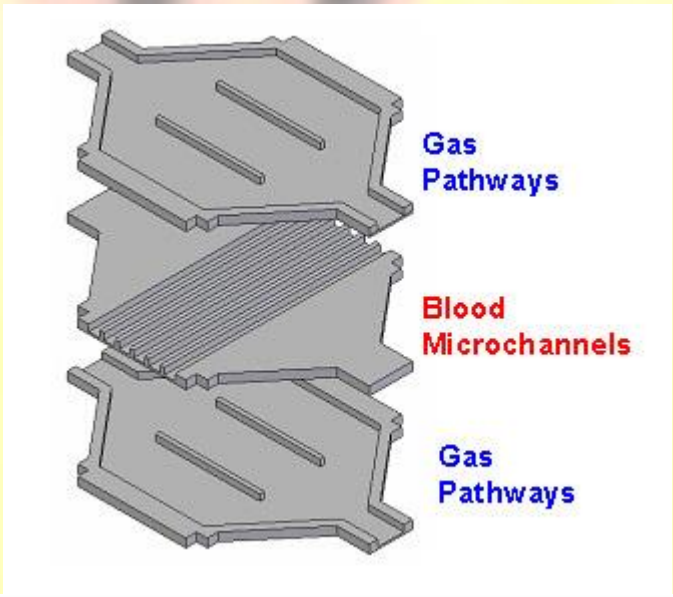
Artificial lung

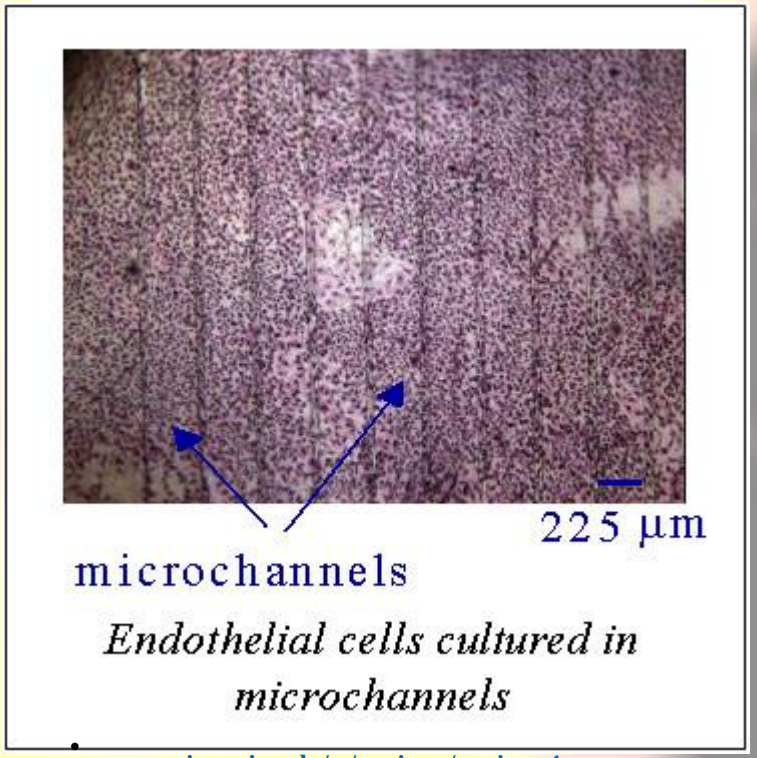


SCHEMATIC DIAGRAM OF HOLLOW FIBER MEMBRANE HEMODIALYZER

NOT DRAWN TO SCALE. Assume flow arrangement is: PURE COUNTERCURRENT FLOW

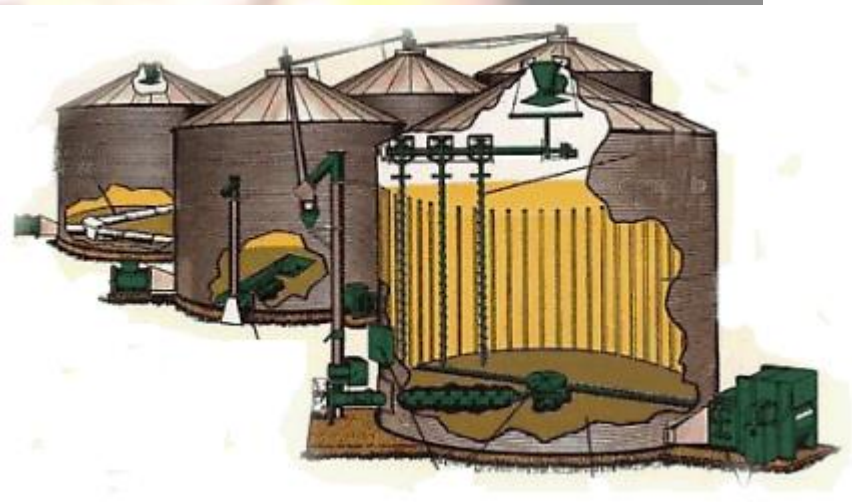
- www.myoops.org/.../CourseHome/index.htm

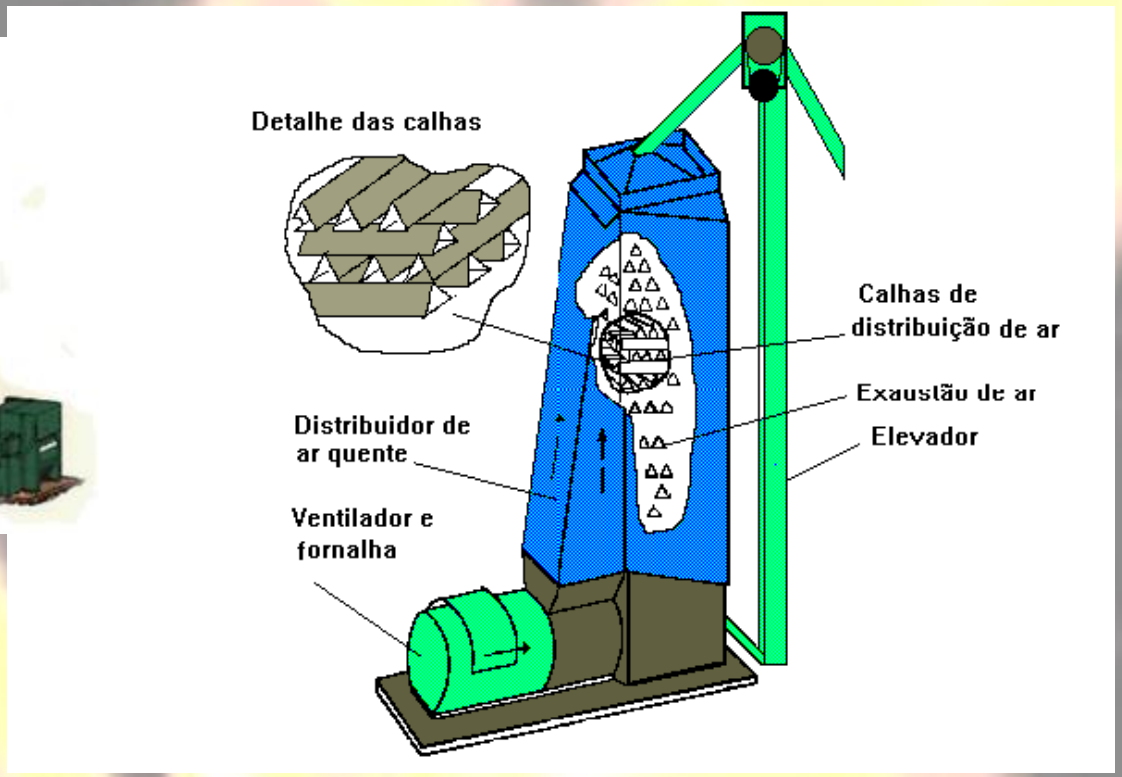




- www.mirm.pitt.edu/.../projects/projects4.asp

Secagem





www.deg.ufla.br/.../SecagemAltasTemperaturas.htm