

First Summer School
Part A: Line-focus Solar Thermal Technologies
September 20-24, 2021

Lecture 8:
Main R+D topics for Line-focus Technologies

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The Objective of current R+D Effort

- ✓ Since the cost of the energy produced by CST systems is still higher than that of conventional systems and the CST technologies are not yet fully mature, a significant R+D effort is currently devoted to:
 - Cost (CAPEX, OPEX) reduction
 - Efficiency increase
 - Better dispatchability
 - Better environmental sustainability
- ✓ At European level, the high priority R+D activities are identified in the *Implementation Plan* of the CSP SET Plan, which is available at:

https://setis.ec.europa.eu/system/files/set_plan_csp_initiative_implementation_plan.pdf

Priority R+D Topics for Cost Reduction

- New solar concentrator designs (i.e. parabolic trough or linear Fresnel) to reduce the amount of manpower for manufacture and on-site assembly, as well as transport cost

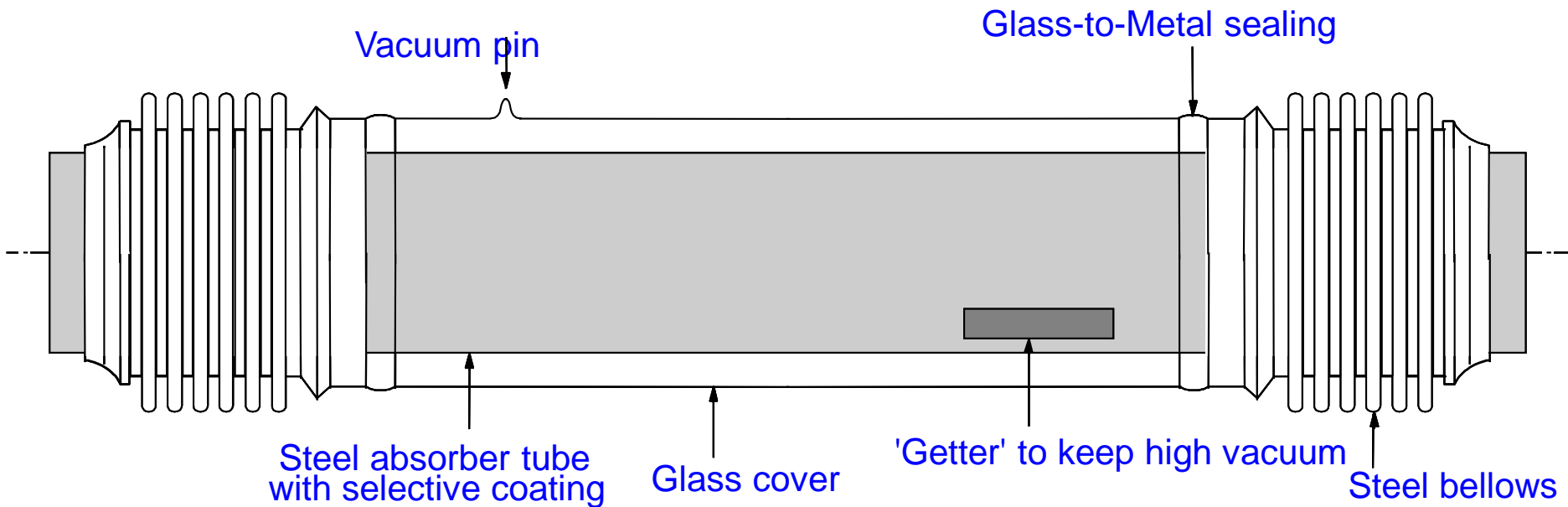


Different steel structures for parabolic-trough collectors



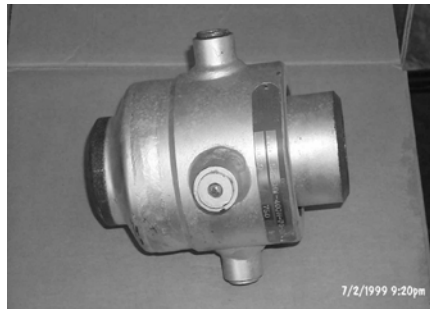
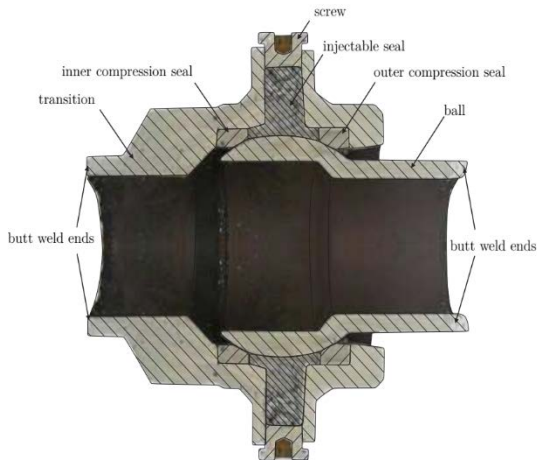
Priority R+D Topics for Cost Reduction

- Development of more durable components (receiver tubes, ball-joints, ..) with lower maintenance costs and higher durability:
 - More durable receiver tubes for line-focusing systems (e.g. better glass-to-metal sealing and less H₂ permeation problems)

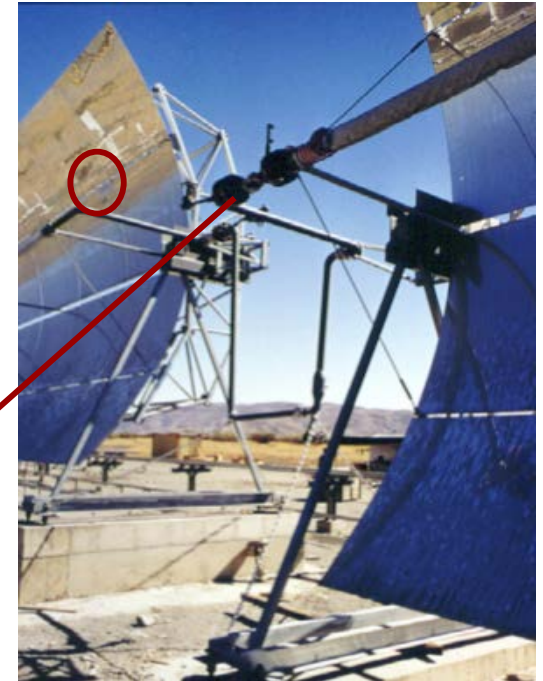


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- Development of more durable components (receiver tubes, ball-joints, ..) with lower maintenance costs and higher durability:
 - More durable receiver tubes for line-focusing systems (e.g. better glass-to-metal sealing and less H₂ permeation problems)
 - Better ball-joints



Typical ball-joint





Priority R+D Topics for Cost Reduction

- Development of more durable components (receiver tubes, ball-joints, ..) with lower maintenance costs and higher durability:
 - More durable receiver tubes for line-focusing systems (e.g. better glass-to-metal sealing and less H₂ permeation problems)
 - Better ball-joints
- Development of new working fluids with lower costs:
 - New thermal oils or salt mixtures with lower cost and melting point



Priority R+D Topics for Efficiency Improvement

- Development of turbo-machinery specially designed for STE plants with a Rankine power cycle
- Development of new working fluids with higher thermal limits :
 - New thermal oils with higher working temperatures

Priority R+D Topics for Better Dispatchability

- Improvement of current heat storage media for sensible heat:
 - Improve the thermo-physical properties (e.g., thermal conductivity, melting point, heat capacity,..) of existing molten salts (nanoparticles ?)



View of a 2-tank molten salt heat storage system



Priority R+D Topics for Better Dispatchability

- Improvement of current heat storage media for sensible heat:
 - Improve the thermo-physical properties (e.g., thermal conductivity, melting point, heat capacity,..) of existing molten salts (nanoparticles ?)
 - Feasibility study of cheap solid storage media (pebbles, industrial by-products,..)
- Development of suitable materials for latent heat storage (PCM) within the range 170°C-275°C

Priority R+D Topics for Better Dispatchability

Latent heat storage (PCM) using nitrate molten salts (250°C-305°C)



200 kWh PCM prototype
(Project DISTOR)



700 kWh PCM prototype
(Project REALDISS)



Priority R+D Topics for Better Dispatchability

- Improvement of current heat storage media for sensible heat:
 - Improve the thermo-physical properties (e.g., thermal conductivity, melting point, heat capacity,..) of existing molten salts (nanoparticles ?)
 - Feasibility study of cheap solid storage media (pebbles, industrial by-products,..)
- Development of suitable materials for latent heat storage (PCM) within the range 170°C-275°C
- Development of feasible thermo-chemical storage concepts:

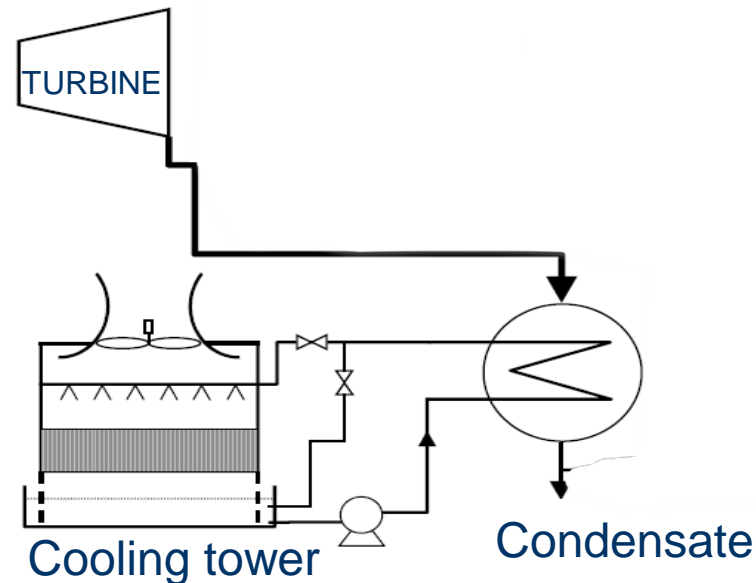


$$\Delta H = 100 \text{ kJ/mol}, T_{eq.} = 507^\circ\text{C}$$



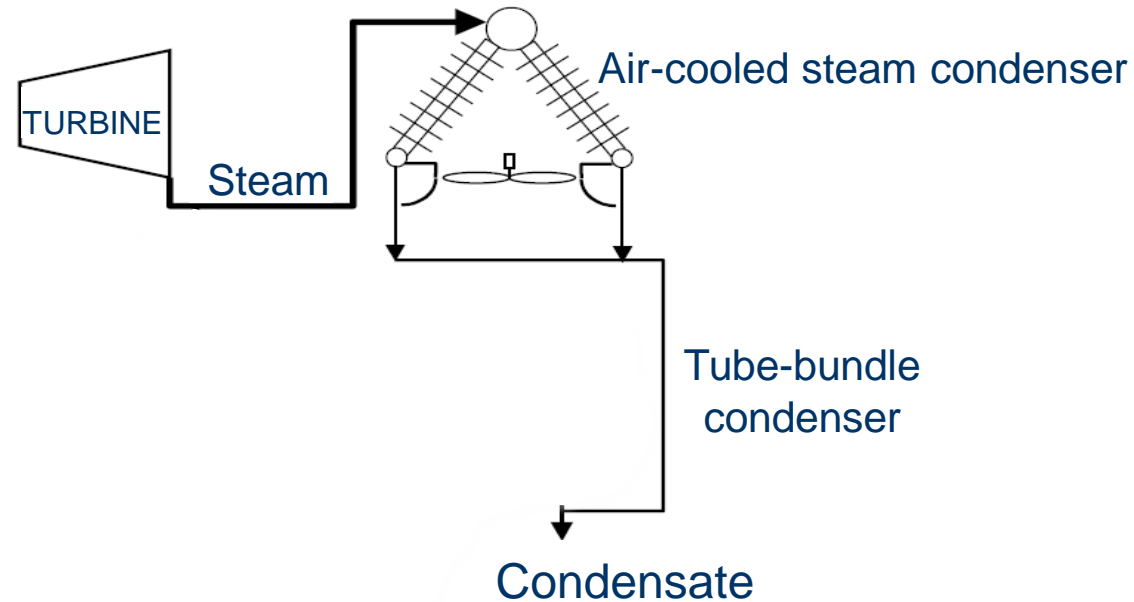
R+D Topics for Lower Environmental Footprint

- ✓ Improvement of dry-cooling systems to reduce their electricity consumption



R+D Topics for Lower Environmental Footprint

- ✓ Improvement of dry-cooling systems to reduce their electricity consumption



- ✓ Dry-cooling systems taking advantage of the lower ambient temperatures at night time (the so-called “negative thermal storage” concept)
- ✓ New working fluids for parabolic troughs with lower environmental impact than current thermal oils (i.e., compressed gases, water/steam, molten salts,....)



Main R+D topics for Line-focus Technologies

Final Remarks

☞ The R+D priority lines for the STE sector have been already defined taking into consideration their impact on: cost reduction, efficiency increase, better dispatchability and lower environmental impact

☞ There are so many interesting R+D topics and their nature is so different that researchers from very different fields (e.g., chemists, physicists, engineers, designers, equipment manufacturers,) and different entities (industries, large R+D centers, small laboratories,....) can contribute to their study and development

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- Thank you very much for your attention**
- Questions?**

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