Non-evacuated and evacuated receivers for concentrating process heat collectors

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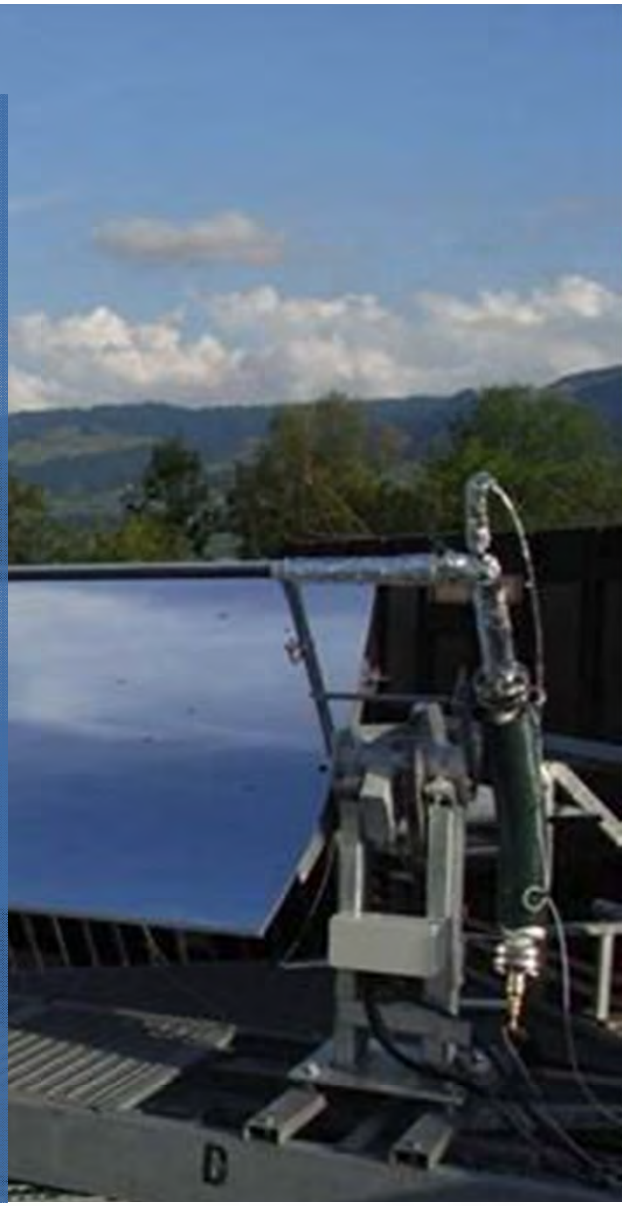

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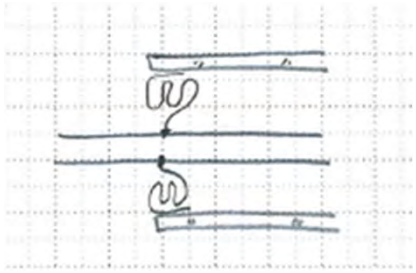
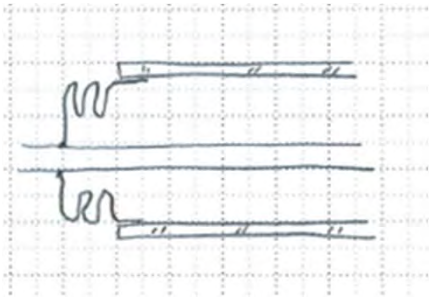
Introduction

- **Most concentrating process heat collectors use non-evacuated receivers**

- **Industrial Solar uses the Schott PRT70 receiver for its linear Fresnel collector. But the absorber tube has a diameter of 70 mm which is much larger than the absorber tubes of most parabolic trough collectors for process heat.**



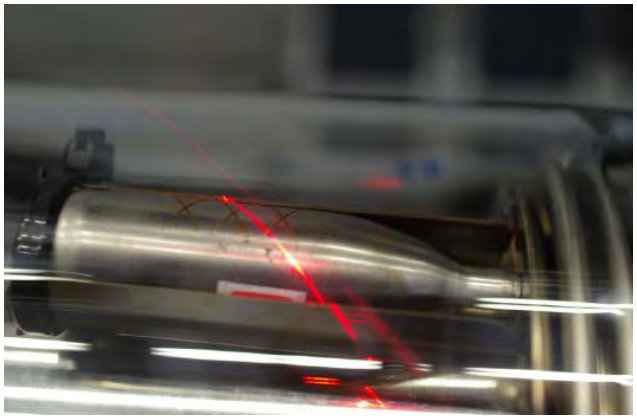


- **Improved Reliability**
  - Improved match between glass and metal coefficients of thermal expansion
  - 100% testing of glass-to-metal seal
  - No glass-to-metal seal failures in field testing to date
- **Improved Performance**
  - New bellows configuration that compresses when tube is hot (~2% benefit)
  - Improved getter mounting to keep getters cool to increase hydrogen absorption capacity
  - More durable anti-reflective coating on glass
- **Selective Coating**
  - Similar to Luz (with Molybdenum)

New Schott Bellows Design

Schott Receivers at APS 1-MWe Trough Plant

New Generation of SCHOTT Receivers



A Neodym YAG Laser (λ=1064 nm) is used to open a Xenon fielld capsule. This will reduce the heat loss of the receiver even if the 'hot tube phenomenon' occured and H_2 is present in the evacuated annulus. The heat losses will be reduced to a level of 130-140% of the heat losses at original vacuum situation ($p < 10^{-3}$ mbar).

Thermo oil based parabolic through technology is limited to operational temperatures close to 400°C due to the decomposition of the heat transfer fluid and accompanying hydrogen permeation into the vacuum annulus. The presence of hydrogen in the annulus leads to an increase of thermal losses and a decrease in thermal efficiency. In order to overcome this so-called 'hot tube phenomenon', SCHOTT introduced the PREMIUM receiver with a capsule containing noble gas placed in the evacuated annulus. The receiver operates after installation with the performance of the standard receiver (PTR 70), until the 'hot tube phenomenon' is detected. The encapsulated noble gas will be released via laser drilling the capsule, without further interruption of the plant operation.

Quelle: SolarPaces 2013, Sohr et al., Laser induced release of encapsulated noble gas in SCHOTT receiver

Introduction

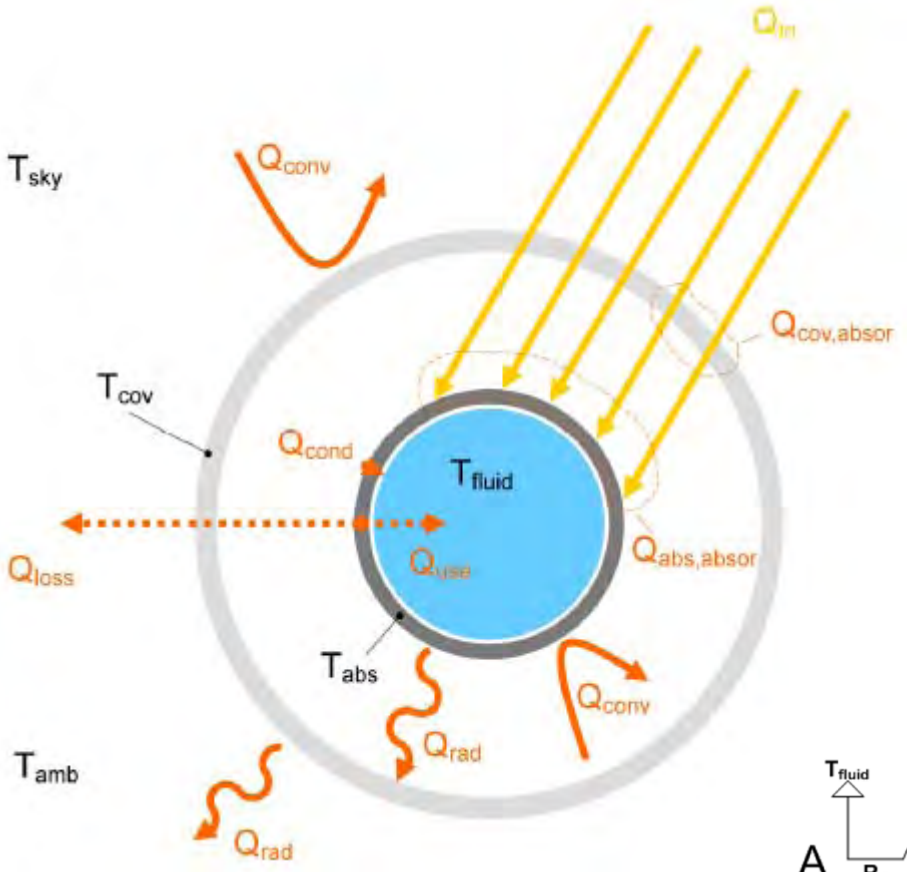
- **Which technical advantages could be achieved by evacuated receivers for concentrating process heat collectors ?**

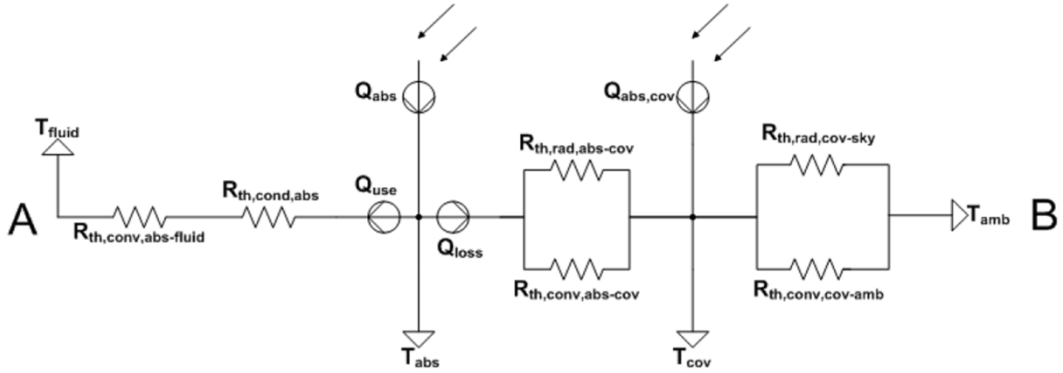
- **Some model-based calculation results are presented here for a discussion if there is interest in the development of evacuated receivers for process heat collectors**

NEP PT1800 collector on test site of SPF

Diameter of absorber tube:	34 mm	(PRT70: 70 mm)
Diameter of glass tube:	56 mm	(PRT70: 110 mm)

Receiver model used for calculations





Parameter variations investigated

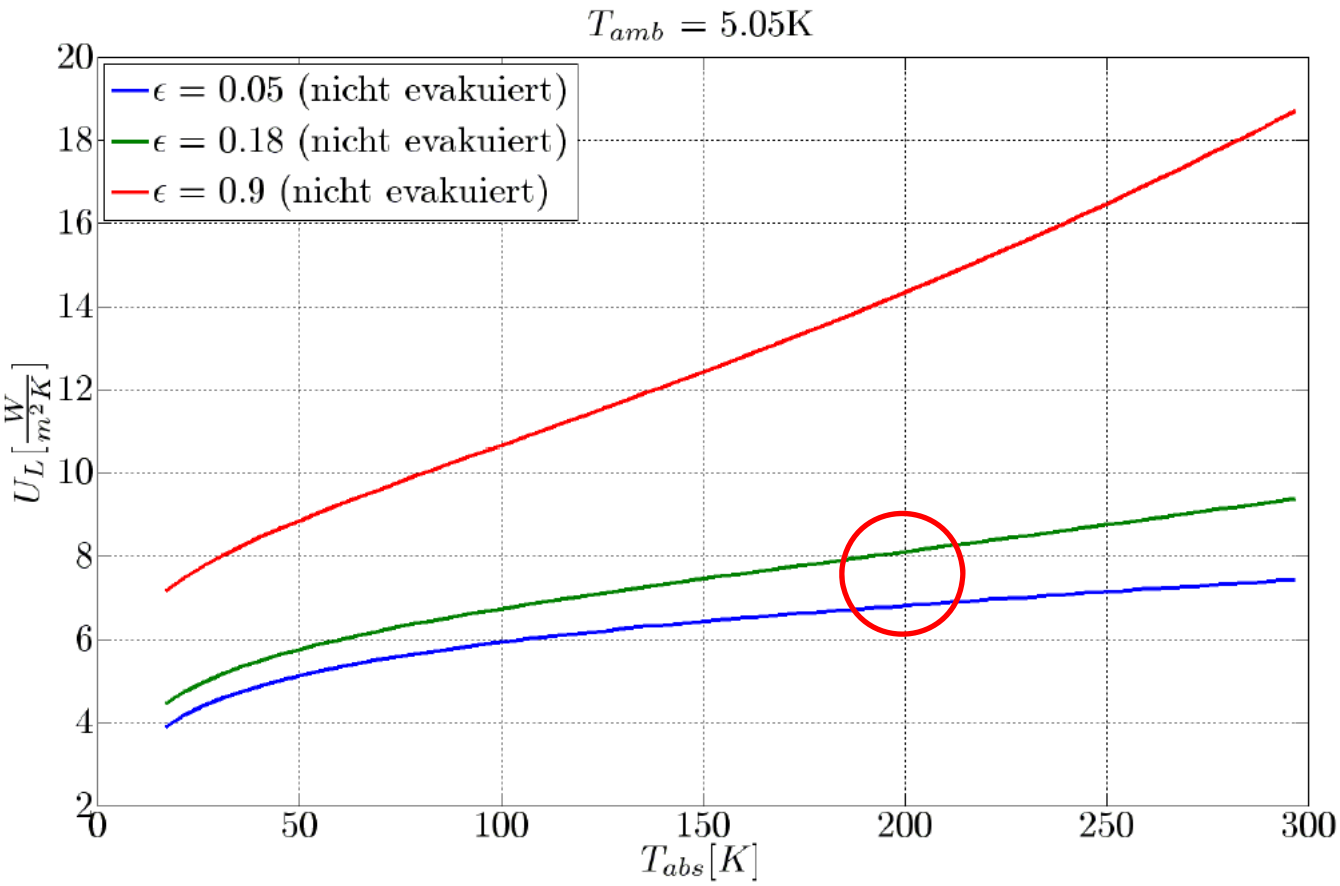
- absorber tube outer diameter 25.7 mm
- absorber tube inner diameter 23 mm
- solar absorptivity coefficient 94%
- IR-emissivity coefficient 5%, 18% and 90%

- glass tube outer diameter 56 mm
- glass tube inner diameter 52 mm

- evacuated and non-evacuated receiver (air)

Non-evacuated receivers

Calculated heat loss coefficients U_L

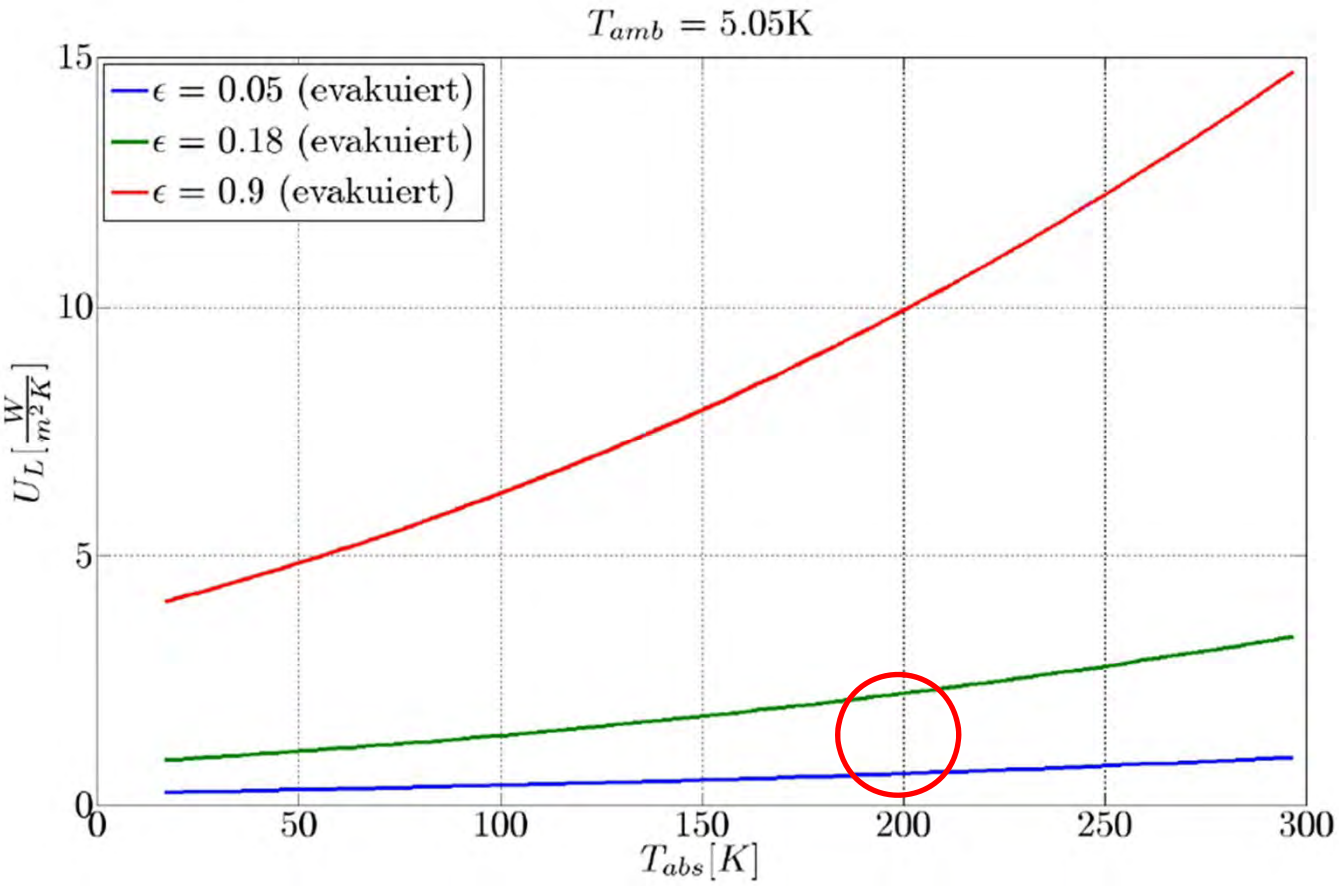


The calculated U_L-values are based on the outer absorber tube area

Typically U_L values are about 7 W m^{-2} K^{-1} for non-evacuated receivers.

Evacuated receivers

Calculated heat loss coefficients U_L



The calculated U_L-values are based on the outer absorber tube area

Typically U_L values are about 1 to 2 W m^{-2} K^{-1} for evacuated receivers.

Comparison of efficiency curves

The possible improvements in the efficiency curve depend on the concentration factor and the optical parameters of the collector.

In this calculated example the efficiency for absorber temperatures of 200°C is increased from about 60% to 73%.

Additional advantages:
- no condensation problems
- selective absorber protected against environment

➡ Discussion on interest in the development of evacuated receivers for process heat collectors?