

Heat Transfer: Radiation

Summary: Procedure for radiation tasks

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Learning goals

Solving radiation problems:

- ▶ Ability to solve radiation problems through a systematic approach.

① _____

② _____

③ _____

Summary

Solving radiation problems:

- ▶ Ability to solve radiation problems through a systematic approach.

Procedure

1. Problem analysis
2. Balance
3. Surface brightness
4. View factors
5. Setting up, solving and remodelling

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Problem analysis

Solving radiation problems:

Problem analysis

Procedure

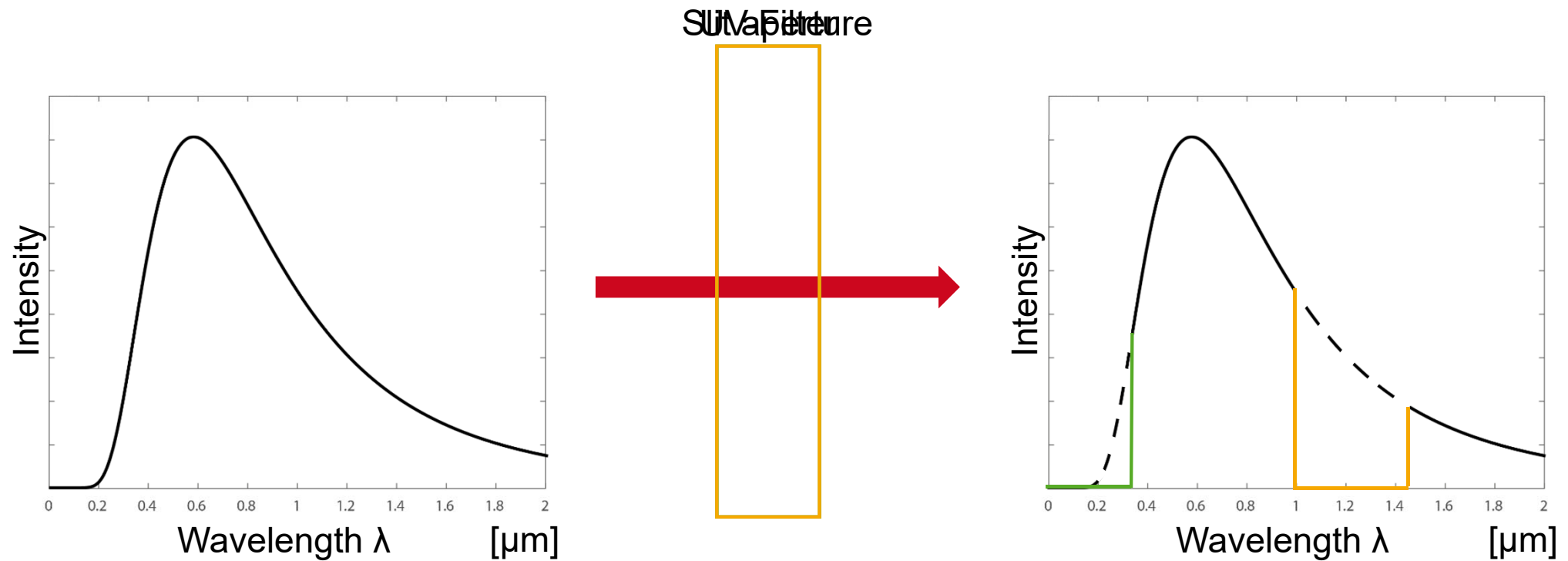
1. Which parameters are given and which parameters are wanted?
2. Is a spectral formulation of the balance necessary?
3. Do the sources radiate diffusely or directionally?
4. Are several bodies involved? (Can bodies be grouped together?)

Problem analysis: Spectral division of heat transfer

Solving radiation problems:

Is a spectral consideration necessary?

e.g. Filter or other medium as glass and atmosphere

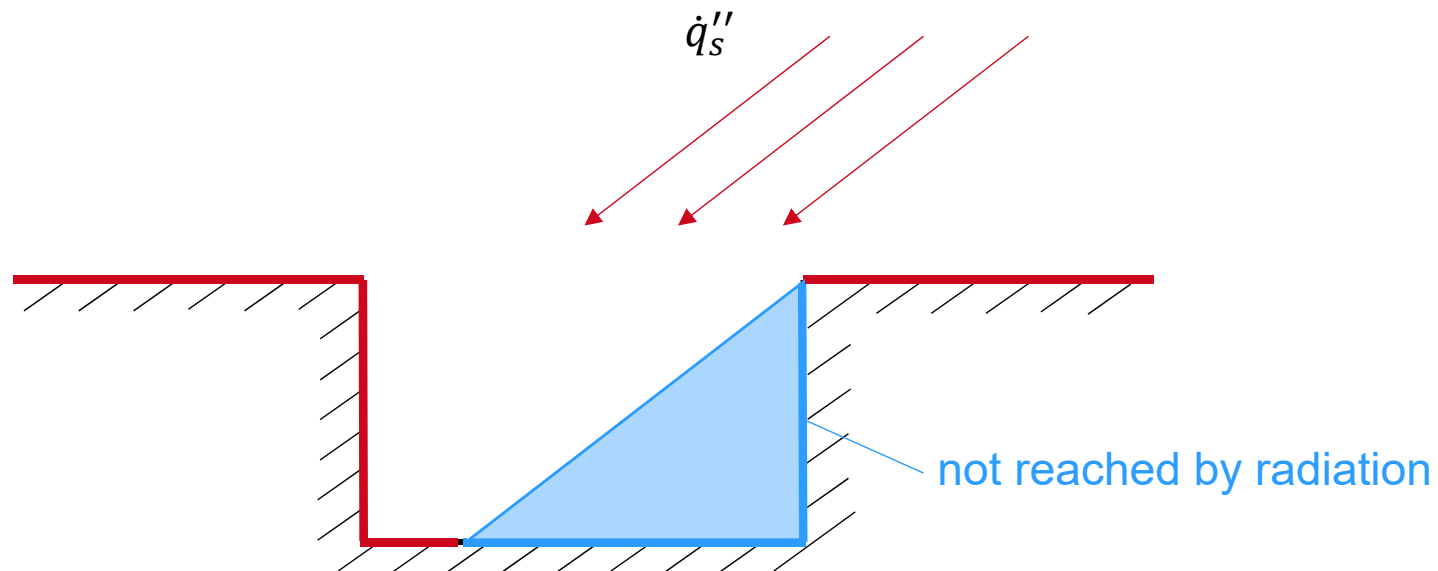


Problem analysis: Diffuse and directional radiation

Solving radiation problems:

Does the source radiate diffusely?

e.g. Solar radiation arriving on earth is considered parallel

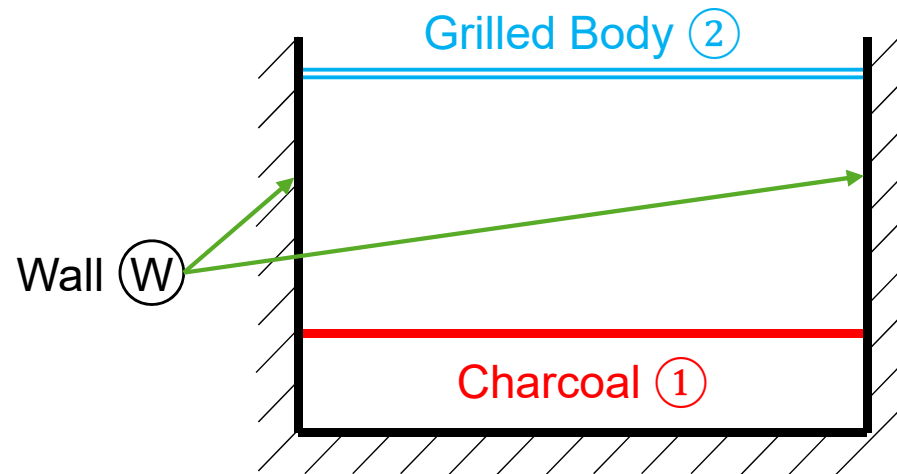


Problem analysis: Diffuse and directional radiation

Solving radiation problems:

Are several bodies involved? Can certain bodies be grouped together?

e.g. Three-body problem



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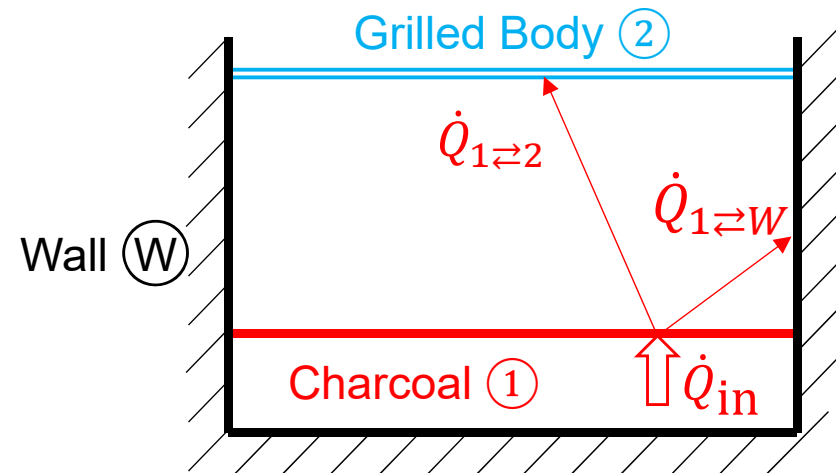
1. Problem analysis
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Solving radiation problems:

Balance

Procedure

1. Number of balances required
2. Establish an inner or outer balance
3. Establish the balance with
 - Surface brightness:
 $\dot{Q}_{\text{in}} = -\dot{Q}_1 + \phi_{21}\dot{Q}_2 + \phi_{W1}\dot{Q}_W$
 - or net radiation heat flux:
 $\dot{Q}_{\text{in}} = \dot{Q}_{1\rightleftharpoons 2} + \dot{Q}_{1\rightleftharpoons W}$
→ see example: Three-body problem



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Set up of surface brightness

Solving radiation problems:

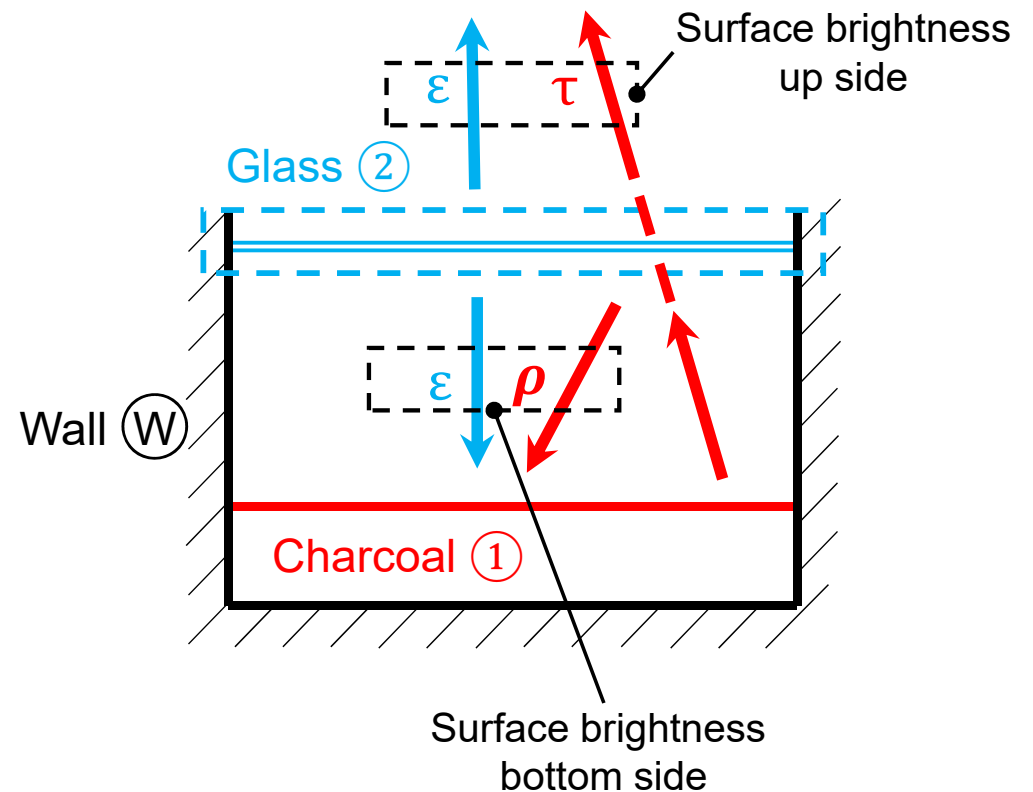
Balance with surface brightness: what belongs to the surface brightness?

Procedure

1. Consider multiple sides
2. Wavelength-dependent optical properties

Important: Implicit setting up as function of the other surface brightness values and view factors

$$\dot{Q}_1(\dot{Q}_i, \phi_{ii}) = \begin{array}{l} \text{Own emission} \\ + \text{Reflection} \\ + \text{Transmission} \end{array}$$



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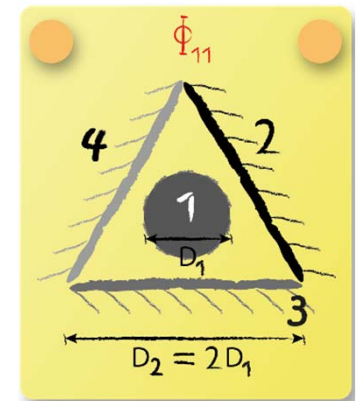
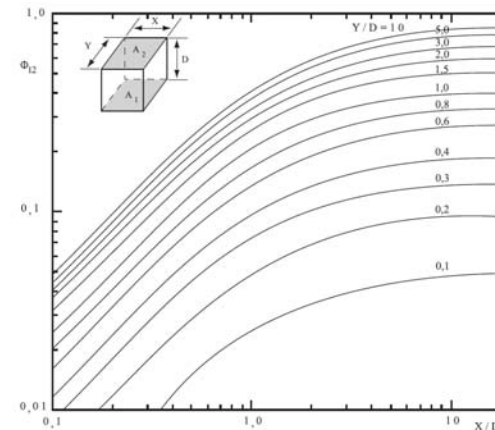
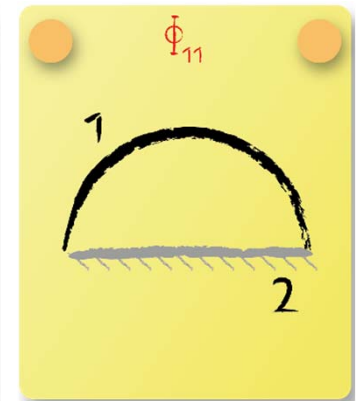
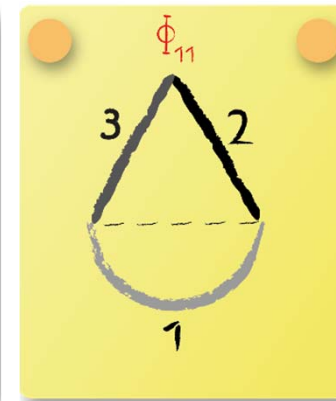
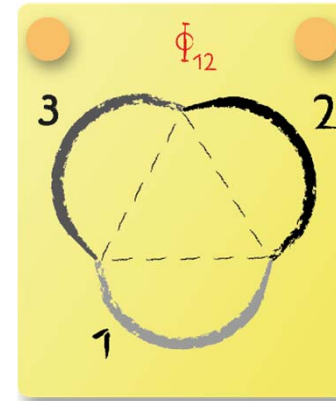
Determination of view factors

Solving radiation problems:

Determination of view factors

Procedure

1. Geometric considerations
 - a. Summation rule
 - b. Reciprocal rule
 - c. Symmetry
 - d. Auxiliary planes
2. With diagrams e.g. from the formulary



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Procedure – steps to be followed

1. Problem analysis
2. Formulate Balance
3. Surface brightness
4. View factors
5. Setting up, solving and remodelling

only if "solving" is required \Rightarrow put 3 & 4 into 2.
otherwise: step 5 is not needed

Comprehension Questions

What are the most important points that need to be clarified before calculating radiation tasks?