Introduction to vacuum technology
Exercises

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April 15, 2025

Exercise 1

Consider a spherical vacuum chamber of radius 10 cm.

a) Assume that an atomic monolayer has a surface atom density of $2 \times 10^{19}\,\text{atoms/m}^2$.
   Starting from a perfect vacuum, with one adsorbed monolayer over the whole internal area, calculate the pressure rise if the whole monolayer is desorbed.

b) When the sphere is vented to atmosphere, ≈ 20 monolayers of water molecules can be adsorbed before pumping down. Assuming that water has the same surface number density as above, what is the pressure in the chamber of a process gas that has the same number of molecules as the water adsorbed on the surface? (Assume that the process gas does not adsorb.)

Exercise 2

Derive the expressions for S_{eff} on slides 35 and 36.

Exercise 3

Consider the vacuum system depicted in Fig. 1 (the schematic is not to scale).

In this exercise, you will characterize the system and find its performance (and limitations) using the vacuum concepts presented in the lecture.

a) Calculate the conductance of the turbopump duct. Consider it as an aperture in series with a cylindrical tube.

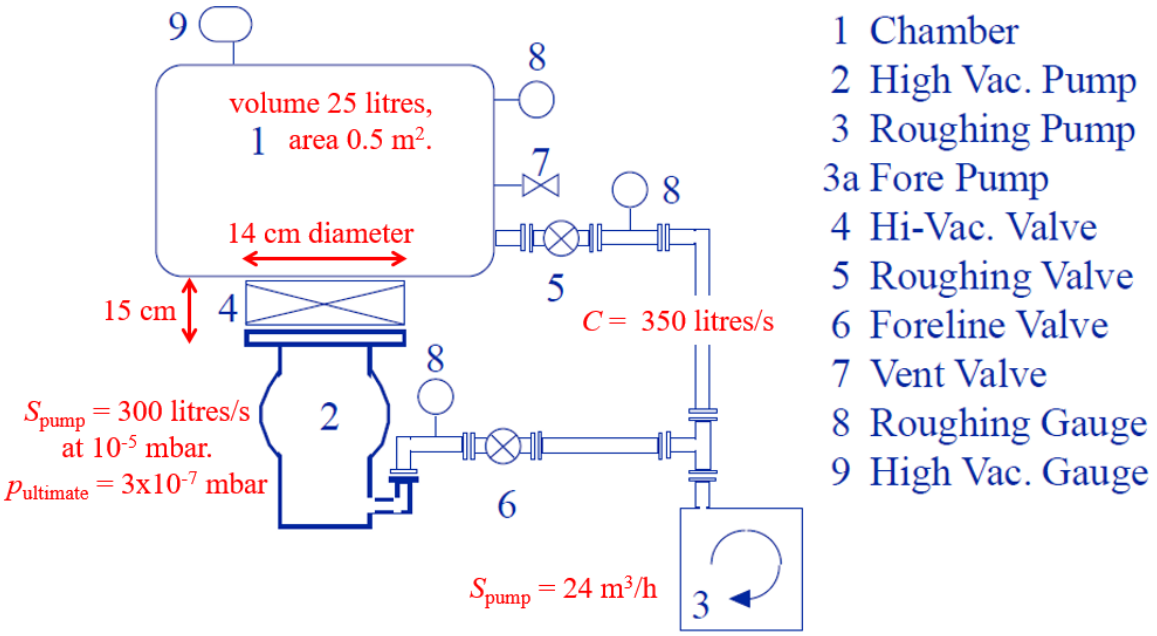

Figure 1: A prototypical vacuum system.

b) Calculate the effective pumping speed of the turbopump.

c) After 50 hours pumping, the base pressure is 4×10^{-7} mbar. Is this an acceptable pressure based on the information given in Fig. 1?

d) What is the outgassing rate? Is the chamber leaktight?

e) What is the effective pumping speed of the roughing pump?

f) The critical backing pressure of the turbopump is 10 Pa. What is the maximum possible process pressure (i.e. pressure in the chamber)?

Is this value of maximum pressure acceptable? How can that value be increased?

g) What is the maximum possible flow rate of a process gas if you wanted to inject one in the chamber?