COMPRESSOR

1.   TECHNICAL DESCRIPTION, BACKGROUND

A compressor, which was designed at the department, needs to be tested to see if the design meets the requirements of the buyer. The fluid to be transported is air, and the size of the pipes in which the fluid is to be transported is given. A required mass flow rate, and average velocity at the outlet from the compressor needs to be examined.

2.   PROCEDURE

How should the mass flow rate and the average velocity be examined?

If the average velocity at the outlet cannot be examined, because the measuring instrument breaks during testing, how can the average velocity and the mass flow rate be determined from the inlet data?

3.   ENGINEERING CALCULATIONS

A/   Calculate the mass flow rate being transported by the compressor.

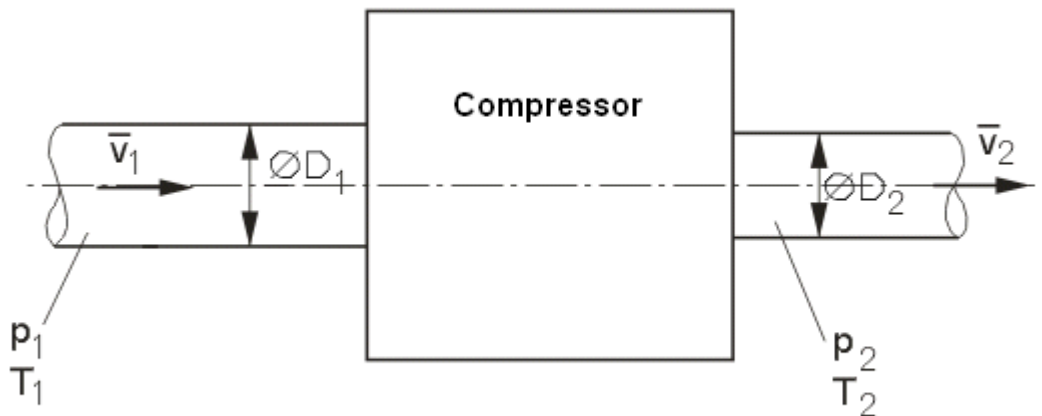B/   Calculate the average velocity at the outlet of the compressor.

Figure 1.

Requirements:

Mass flow rate at outlet $\dot{q}_m = \left[\dfrac{kg}{s}\right]$

Average velocity at outlet $\bar{v}_2 = \left[\dfrac{m}{s}\right]$

Fluid Data:

Gas constant of air $R = 287$ [$J/(kg\ K)$]

Inlet Data:

Inlet pressure $p_1 = 1.02\,\text{E5}\,[Pa]$

Inlet temperature $T_1 = 290\,[K]$

Inlet diameter $D_1 = 100\,[mm]$

Inlet average velocity $\bar{v}_1 = 18\,\left[\dfrac{m}{s}\right]$

Outlet Data:

Outlet pressure $p_2 = 5\,\text{E5}\,[Pa]$

Outlet temperature $T_2 = 340\,[K]$

Outlet diameter $D_2 = 80\,[mm]$