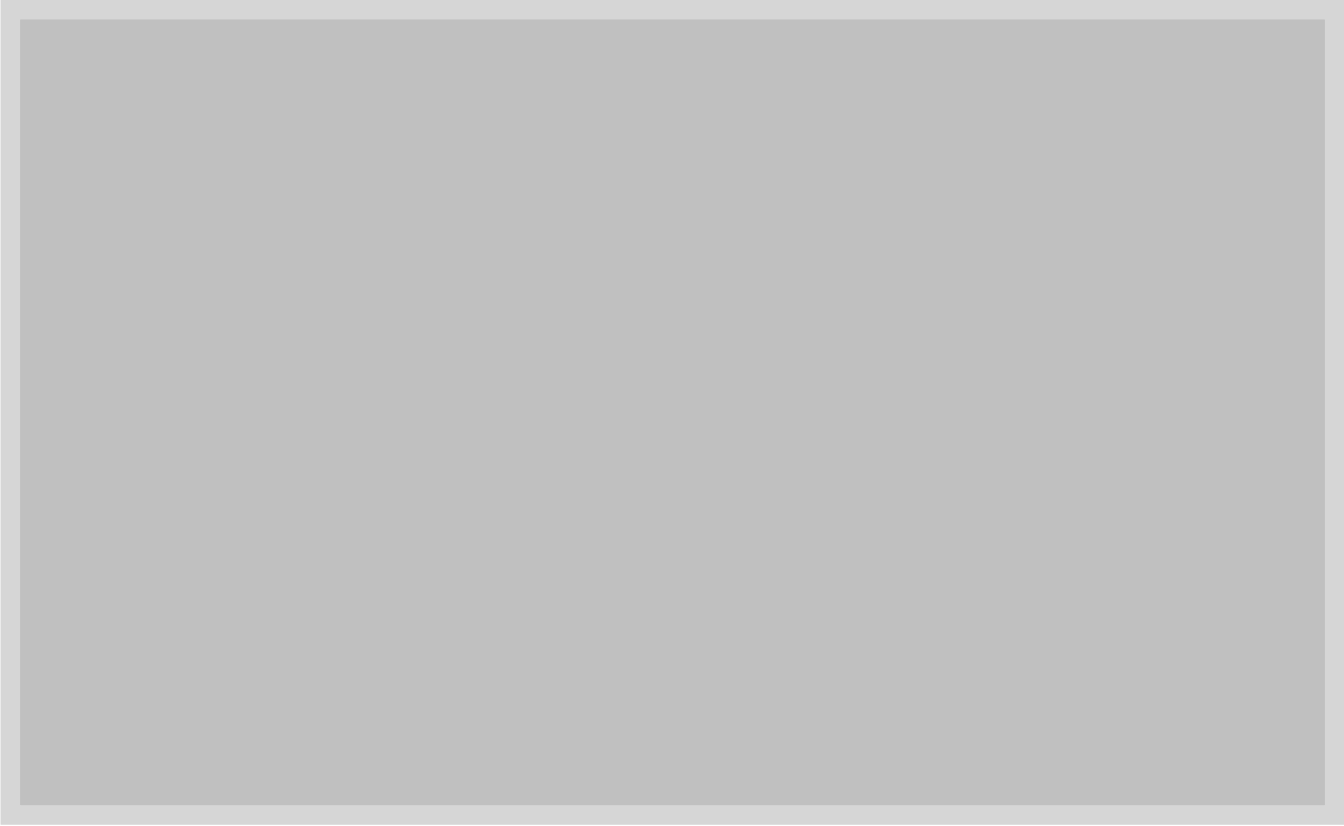


Introduction

This assignment involves modelling, analysis, simulation and design optimisation of a pipe flow reducer component of a piping assembly as shown in figure 1. The piping assembly consists of filter, flow reducer and regulator valve. The pipe flow reducer is used to increase the velocity of fluid and reduce the pressure of fluid before it enters the regulator valve. The tasks involved in the assignment involve selection of suitable material satisfying the function, objectives and constraints of the problem, modelling of reducer, perform finite element analysis and design optimisation as well as flow simulation within the pipe reducer.

Task 1 (Selection of Material)

- Using the method adopted for simply supported beam for material selection, find the best material for the "Flow Reducer" by deriving suitable material property indices using following data
  - **Function**: Material selection for a cheap, light, stiff and strong pipe flow reducer.
  - **Objectives**: Minimise mass and minimise cost
  - **Constraints**:
    - Length of reducer is fixed
    - Must not fail under applied load
    - Must resist deformation under applied load
    - Must have adequate toughness
  - **Assumptions:**
    - For the sake of simplicity assume pipe reducer as a hollow pipe with uniform cross section.
    - The outer diameter D of pipe is 1.12 times of internal diameter.
    - Assume the pipe is built in (fixed) on both sides with a uniformly distributed load
- Select those materials which can be "Sand Cast" using "Tree" function of CES software. Apply the derived material property indices in the CES software using the "Graph"

function and find the best material with the final criteria to be low cost. Produce a small report describing the whole procedure i.e. deriving material property indices as well as inserting screen shots from material selection. Critically evaluate your material selection and save all projects in the USB stick. **(25 Marks)**

Task 2 (Modelling, Analysis & Optimisation)

- Model the pipe reducer according to the sketch given along with a drawing preparation on A3 size and save the model and drawing in USB stick

  (10 Marks)
- Perform FEA using Simulation Professional module of SolidWorks with following parameters
  - Apply the material selected in task 1 on the part.
  - Constrain the inner faces of holes on both plates as well as constraining the movement of outer faces plates in the direction perpendicular to faces
  - Apply an internal pressure of 3500 psi as shown in figure 2.
  - Use a finest mesh
  - Run the model

  (10 Marks)
- Display graphs and images of stresses and displacements and areas where factor of safety is less than 3.5. Critically evaluate the FEA process in your report and include the report generated by software as appendix. Include the FEA simulation video clips and analysis file in the USB stick. **(10 Marks)**
- Optimise the design parameters using multi criteria design optimisation technique to bring the minimum factor of safety to 2. Identify the parameters which need to be optimised. Give the optimum value of these parameters. Calculate the new mass, old mass, percentage saving/increase in mass. Critically evaluate the whole optimisation process and include key screen images as well as the optimisation study in the USB stick. **(10 Marks)**
- Repeat the above procedure of FEA and Optimisation using "Copper" material as well as submit images and report **(10 Marks)**

Task 3 (Flow Simulation)

Using the example of "ball valve assembly" shown in the class, perform flow simulation of water flow in the pipe reducer using the selected material in task 2 and using flow parameters in SolidWorks Flow Simulation Professional module:

- Create lids of 4 mm thick on both inlet (bigger diameter) as well as outlet (smaller diameter) sides. Make sure that the lids are transparent and not shown during the simulation of flow. **(4 Marks)**
- Apply a pressure of 3500 psi (covert it to pascals) to the inlet face as well as apply $6x10^{-4}$ m^3/sec volume flow rate at the outlet face as shown in figure 3(a) and 3(b). **(6 Marks)**
- Run the model
- Create a cut plot of velocity in top plane.
  Create a surface plot each for temperature and pressure.
  Create flow trajectories plot for velocity. **(3 Marks)**

- Save the animated video clips for the above mentioned plots as well as the whole project in USB stick. **(5 Marks)**

- Generate a report of flow simulation using create report option of the software with manual addition of images of all four plots as well as critical evaluation of flow analysis from your side. **(7 Marks)**

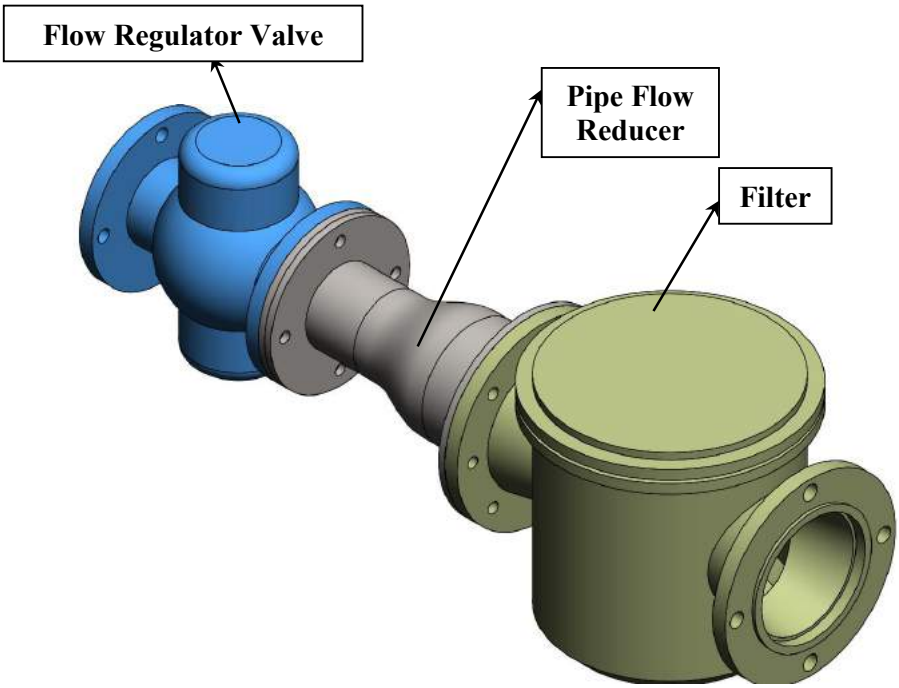


Figure 1: Piping Assembly showing "Pipe Flow Reducer"

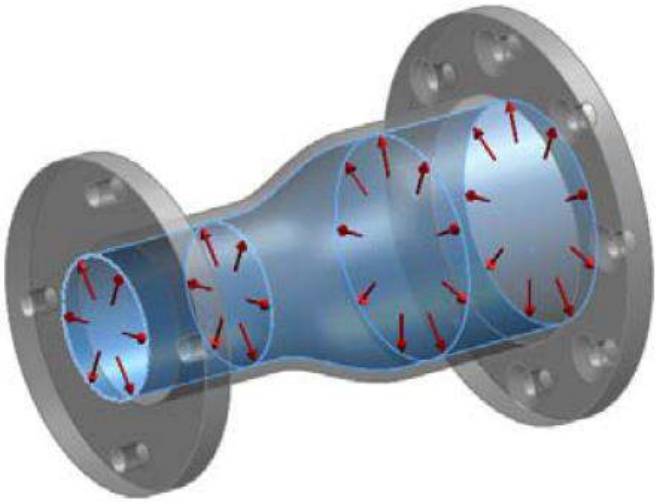


Figure 2: Pressure of 3500 psi on Pipe Reducer

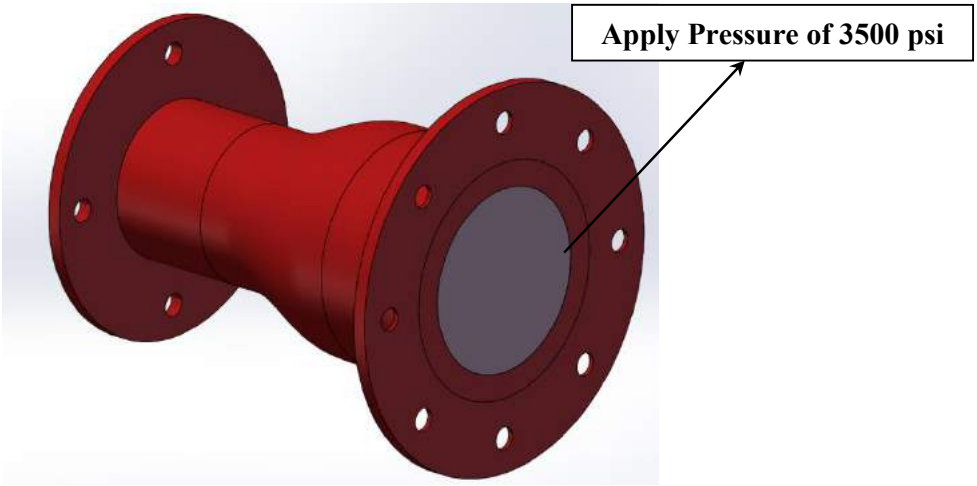


Figure 3(a): Application of 3500 psi at inlet of Pipe Reducer

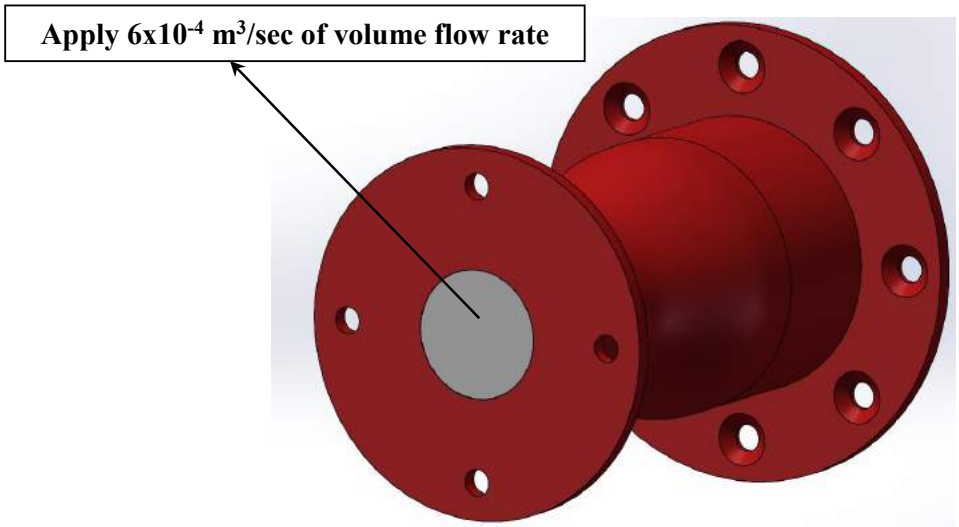
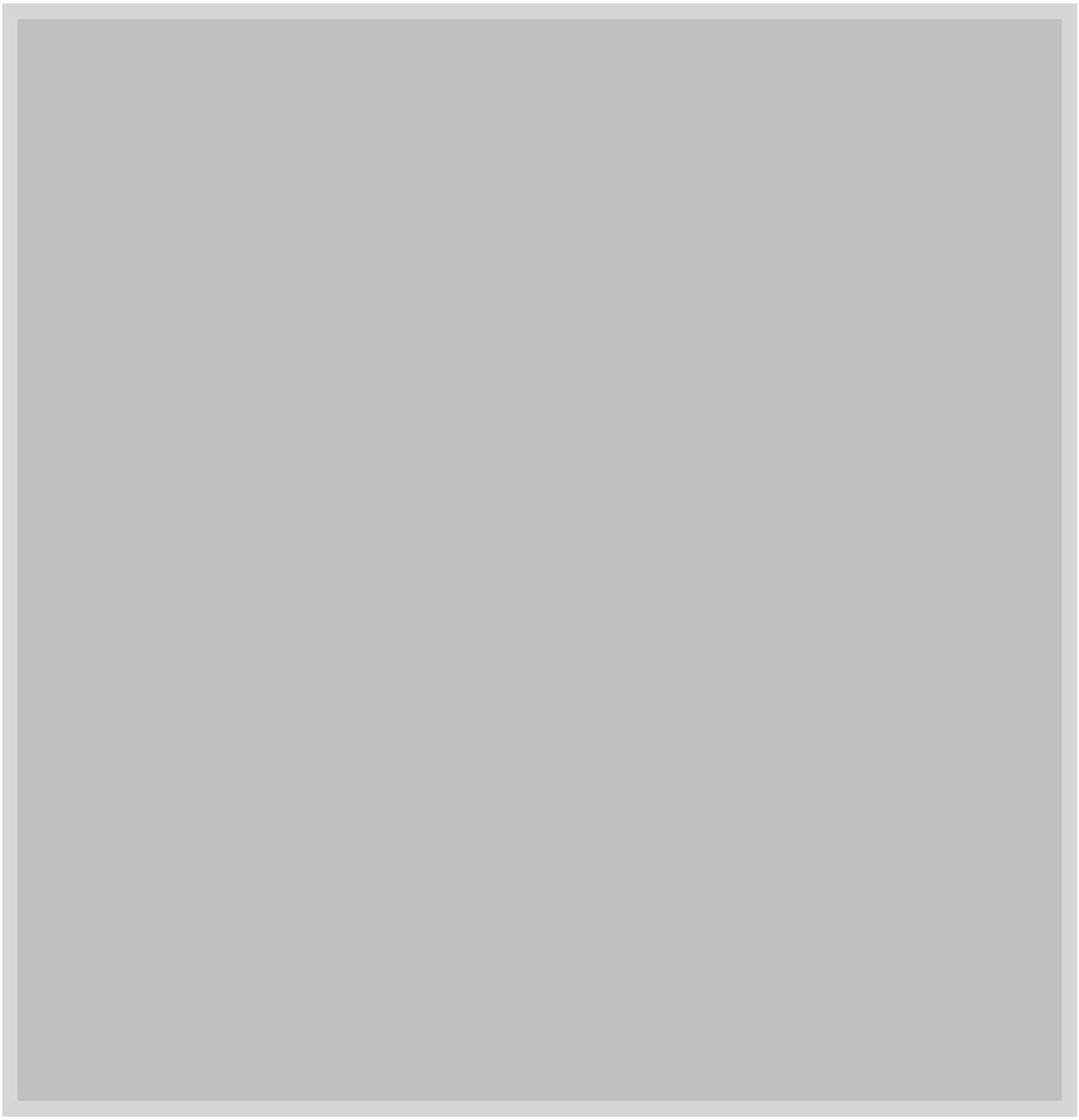
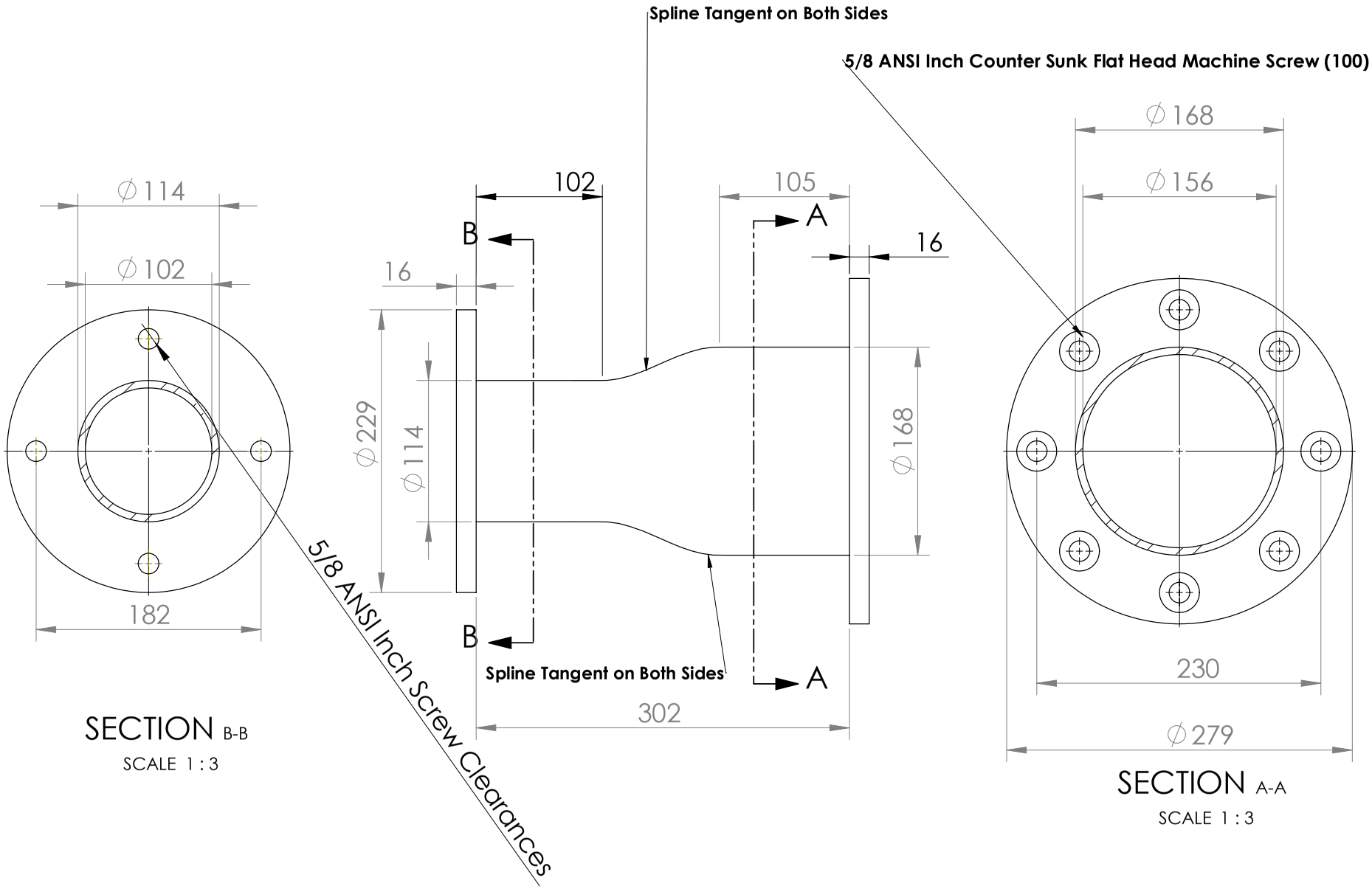


Figure 3(b): Application of $6x10^{-4}$ m^3/sec of volume flow rate at outlet of Pipe Reducer





PIPE FLOW REDUCER for AE1 DES600