**Assignment: Pipe design**

The figure shows a plan view of a steam supply pipe from separator (A) to turbine inlet (D). The distance (straight) from B to C is 100 m and “x” is 15 m. A & D are fixed points. Total pipe length is thus 130 m.



The rated steam flow at turbine inlet is 11,8 kg/s @ 13 bara saturated steam. The rated generator output is 5,5 MW.

1. Select the optimum diameter for the pipe and calculate the total pressure drop (30)

* The power output changes 200 kW pr. bar
* The power production is constant for 8.000 h/year
* Unit pipe cost is 3,5 €/mm x Di pr. m (neglect wall thickness and standard diameter)
* Penalty for less electricity produced: 0,06 €/kWh
* Annual maintenance cost of the pipe is 2% of piping cost installation cost
* Pipe roughness: k: 0,1 mm (neglect unit losses, bends etc.)
* Use 10% discount rate and 20 years for present value calculation

1. Select a standard size, DS, pipe diameter and calculate minimum wall thickness e, for the pipe selected in a) (5)

* Design Pressure: 1,4 x operating pressure
* Design Temperature Saturated vapor @ design pressure
* Seamless pipes: z = 1,0
* Material: P235GH acc. to EN 10216

1. Calculate required thickness, er, select the ordered thickness eord  = en and calculate eas  (5)

* Corrosion allowance: 2 mm
* Manufacturing allowance 8% of selected wall thickness

1. Design a reinforced DN 200 (DB = 219,1 mm) branch on the pipe, representing a drain-pot (drip leg). Select the branch pipe wall thickness, e, er, eord and eas. If needed, select greater wall thickness in c) to be able to design the reinforced branch with allowable reinforcement plates (collars) (15)
2. The pipe will be insulated with rock wool; 60 mm thick, 150 kg/m3 and the cladding will be 1,0 mm (20) aluminum. Other loads such as occasional loads shall be neglected, wind earthquake etc.
   1. Calculate the total sustained load (N/m)
   2. Select distance between supports.
      1. The stresses shall be within limit
      2. Distance (between supports) /deflection > 1000.
      3. Make a plane view drawing showing the support location
3. Determine the allowable stress range. The installation temperature is 10°C. (5)
4. Calculate the in-plane moments and stresses at A & D and in the bends due to thermal loading. (5)
5. Calculate the stress intensity factor for the bends. R=1,5D and R=2,5D (5)
6. Check if the stresses due to thermal loading are within the stress range limitations for A & D and the bends. Evaluate using R=1,5D og R=2,5D (5)