*** Examination ***

Hydraulic Design of Gas or Vapor Piping Systems

Select the best answer to the following questions

1. Why is it necessary to consider additional parameters in the calculation of the pressure drop of gaseous flow in pipe which are not normally incorporated in the pressure drop calculation for the liquid?

   (a) the gas is compressible
   (b) the gas flowing density can change appreciably along a pipe segment
   (c) the gas can accelerate in the pipe run
   (d) all of the above

2. What are the major additional parameters used in the calculation of the pressure drop of gaseous flow in pipe which are not normally incorporated in the pressure drop calculation for the liquid flow?

   (a) the gas flowing temperature
   (b) the gas flowing pressure
   (c) the property of the gas such as the density
   (d) all of the above

3. Equation of state is used to calculate the gas density which is effected by

   (a) the gas flowing temperature
   (b) the gas flowing pressure
   (c) the properties of the gas such as the molecular weight
   (d) all of the above

4. A gas of specific gravity 0.7 means

   (a) the gas has a molecular weight of 0.7 times that of air
   (b) the gas has a molecular weight of 0.7 times that of water
   (c) the gas has a standard density of 0.7 times that of air at 14.7 psia & 60^oF
   (d) the gas has a standard density of 0.7 times that of water at 14.7 psia & 60^oF

5. Sonic velocity of a gas is governed by

    (a) the gas flowing temperature
    (b) the property of gas such as ratio of Cp to Cv
    (c) the property of gas such as the molecular weight
    (d) all of the above

6. If gas flows through pipe of constant inside diameter with negligible heat loss or gain,

    (a) its velocity is proportional to the square of its flow rate
    (b) its velocity is proportional to its flow rate
    (c) its velocity is proportional to the square root of its flow rate
    (d) none of the above

7. You want to deliver a gas at a target flow of 10,000 lb/hr at 404 deg F with the following properties
    - molecular weight = 16
    - ratio of heat capacity = 1.1
    - compressibility factor = 1.05

    to a location by a pipe of 4 inches inside diameter at pipe outlet pressure lower than 140 psia.

    (a) I cannot determine if the target flow rate is achievable or not because I don't have sufficient information yet such as pipe run length
    (b) I cannot determine if the target flow rate is achievable or not because I don't have sufficient information yet such as the critical pressure
    (c) The target flow rate can be achieved as long as I have sufficient inlet pressure to push the flow through
    (d) The target flow rate cannot be achieved because sonic pressure occurs before the pipe exit to limit the flow

8. A gas flowing through a pipe upward for 144 feet of elevation change at a density of 1 lb/CF resulting a total frictional pressure drop of 10 psi

    (a) the dynamic head loss is 10 psi
    (b) the dynamic head loss is 1440 ft
    (c) the total pressure drop is 11 psi
    (d) all of the above

9. Which of the following fluid parameters may not be used directly to calculate the Reynolds number without appropriate adjustment other than unit conversions?

   (a) fluid's density at the flowing condition
   (b) fluid's viscosity at the flowing condition
   (c) fluid's velocity at the flowing condition
   (d) fluid's density at the standard condition (for example, 1 atm & 60^{o}F)

10. Reynolds number for in-plant gas piping or cross-country gas pipe line is most likely

   (a) less than 2,000
   (b) In between 2,200 and 4,000
   (c) less than 4,000
   (d) greater than 10,000

11. Under which situations below can one consider applying Darcy's equation to calculate the gas flow frictional pressure drop:

   (a) "shorter" pipe run length
   (b) Heat transfer is insignificant
   (c) Calculated pressure drop is within 10% of the inlet pressure
   (d) All of above

12. Reasons that Darcy's equation shall be used for gas frictional pressure in pipe with caution:

   (a) Darcy's equation is good for constant flowing density
   (b) Darcy's equation is good for constant flowing temperature
   (c) Darcy's equation does not consider gas acceleration in the pipe
   (d) All of above

13. A natural gas piping system is exhibiting 8 psi frictional pressure drop at 1000 psig & 70^{o}F inlet condition. If this flow system flows the same natural gas at 500 psig & 70^{o}F inlet condition, the anticipated new frictional pressure drop would be

   (a) still going to be approximately 8 psi
   (b) increased to approximately to 16 psi
   (c) decreased to approximately to 4 psi
   (d) undetermined with the given information

14. A natural gas is flowing in turbulent flow through a pipe run in a typical in-plant piping at 39 scfm with 20 psi frictional pressure drop. If the flow rate is increased to 78 scfm, assuming everything else stays constant, then the corresponding frictional pressure drop can be anticipated to be in the order of

    (a) $20 \times (78/39)^{1/2} = 28$ psi
    (b) $20 \times (78/39) = 40$ psi
    (c) $20 \times (78/39)^{2} = 80$ psi
    (d) $20 \times (78/39)^{5/2} = 113$ psi

15. What is the purpose that the net expansion factor term is incorporated to Darcy's isothermal equation for the gas frictional pressure calculation in pipe?

    (a) to account for the gas acceleration effect in pipe
    (b) to account for the gas expansion effect in pipe
    (c) to account for the gas temperature change due to expansion
    (d) (a) and (b)

16. Using isothermal incompressible flow equation, following are the calculation results for air flowing at 60^{o}F at the inlet of flow line of 1,000ft length:
    Flow rate = 10,000 lb/hr, ID = 6", Inlet pressure = 369 psig, outlet pressure = 355 psig.
    If considering isothermal compressible flow approach as an alternate calculation using all the same parameters above except the flow rate, the calculated flow rate by the isothermal compressible approach would be

    (a) greater than 10,000 lb/hr
    (b) identical to 10,000 lb/hr
    (c) smaller than 10,000 lb/hr

17. Under the same situation as in Question 16 above.
    If considering isothermal compressible flow approach as an alternate calculation, given the same parameters above except the outlet pressure, the calculated outlet pressure rate by the isothermal compressible approach would be

    (a) higher than 369 psig
    (b) identical to 369 psig
    (c) lower than 369 psig

18. Under the same situation as in Question 16 above.
    If considering isothermal compressible flow approach as an alternate calculation, given the same parameters above except the ID, the calculated ID by the isothermal compressible approach would be

    (a) greater than 6”
    (b) identical to 6”
    (c) smaller than 6”

19. A calculated pressure drop using Darcy’s incompressible frictional pressure drop equation for a gas piping run is 25 psi at an inlet pressure of 250 psig:

    (a) The calculated result is reasonable to accept
    (b) This calculated result perhaps is not accurate
    (c) Information given is not sufficient to determine the accuracy of result

20. Which of the following equation probably is **not** suitable for the long gas pipe line pressure drop calculation:

    (a) Isothermal compressible Rational formula

    $$\Delta P_{f,\ psi} = \left(\frac{f L_{ft}}{D_{ft}}\right)\frac{P_{1,\ psia}}{P_{avg,\ psia}}\frac{(\rho_{1,\ lb/CF})(\upsilon_{1,\ fps})^2}{2g_c(144)}$$

    where $P_{avg,\ psia} = \dfrac{P_{1,psia} + P_{2,psia}}{2}$ and “1” refers for the inlet; “2” for outlet

    (b) Isothermal incompressible Darcy equation

    $$\Delta P_{f\ psi} = \left(f\ \frac{L_{ft}}{D_{ft}}\right)\frac{(\rho_{1,\ lb/CF})(\upsilon_{1,\ ft/\sec})^2}{(2)(g_c)(144)}$$

    where “1” refers for the inlet

    (c) Weymouth formula
    (d) Panhandle A formula

*** EXAM ANSWER SHEET ***

Hydraulic Design of Liquid or Water Piping Systems

Fill in one circle as answer to each question

	a	b	c	d
1	O	O	O	O
2	O	O	O	O
3	O	O	O	O
4	O	O	O	O
5	O	O	O	O
6	O	O	O	O
7	O	O	O	O
8	O	O	O	O
9	O	O	O	O
10	O	O	O	O
11	O	O	O	O
12	O	O	O	O
13	O	O	O	O
14	O	O	O	O
15	O	O	O	O
16	O	O	O	O
17	O	O	O	O
18	O	O	O	O
19	O	O	O	O
20	O	O	O	O

I hereby certify that I have studied the course materials and answered the above question on my own. No other person has helped me complete this exam.

Signature Date

Print Name State Number