Plus Report Bonus

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As a new subscriber to ChE Plus, let me be the first to say "Thank you!" I'm sure that you'll enjoy the service and find it a great value. As part of our thanks, we've included in this document 50 great technical questions and answers here to get you started as a new member of the best chemical engineering online community. In addition, you'll find other great items with your download such as software tools and our award listing of Experienced-Based Rules of Chemical Engineering.

Welcome to ChE Plus!
Sincerely,

Christopher M. A. Haslego

Christopher M. A. Haslego
President
Cheresources, Inc.

****
1. Where can one get a good, extensive list of Henry's Law constants?
****
As of January 31, 2003, the following website:
http://www.mpch-mainz.mpg.de/~sander/res/henry.html
provided a good listing that you can download by using the list below.
Be sure to review the instruction for utilizing the chart as well.

****
2. What are some common methods for helium leak testing a vacuum system?
****
It's commmon to have a location in the suction line of the pump to detect the helium. Then, the helium source is passed over the flanges and other possible sources of leakage. This is done while monitoring the detector at the pump suction for detectable amount of helium.

Alternatively, if your system can take pressure as well as vacuum you can try pressuring it up and looking for the leaks that way.

As yet another alternative, you can install an IR unit to the suction of the pump and spray isopropyl alcohol on the flanges.

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****
3. What type of pump may be appropriate for a liquid near saturation, a low flow rate, and very limited NPSHa (net positive suction head available)?
****

This application is nearly perfect for a turbine regenerative type of pump.

Factors that immediately identify your application and pump type are: the small flowrate, low NPSHa, and high temperature. The regenerative turbine was specifically developed for these conditions and one more: high discharge pressures. The high discharge pressure may not be necessary, but the regenerative turbine can give you a NPSHr of 0.5 feet with ease. They are particularly suited to saturated boiler feed water and your application is similar, albeit not in pressue.

****
4. What's the best way to operate/control a double pipe heat exchanger to avoid the vaporization of the cooling medium for high temperature duties?
****

BACKGROUND
While cooling a very hot viscous product, the water flow rate is being controlled by the process side outlet temperature. The water flow rate is being reduced to a rate at which it forms an annulus, vaporizes, and cause hammer in the equipment.

ANSWER
This is a common scenario when a double-pipe exchanger is operated in counter-current flow. It become difficult to control and the utility side can vaporize causing problems as noted.

By putting the fluids in parallel configuration, you create a situation where you can throttle the water outlet in accordance with the desired process fluid outlet temperature in an accurate and controlled manner. You can do this manually or automatically with a temperature transmitter-temp controller-water control valve. Depending on the process outlet temperature, you may have to maintain a pressure in the annulus that corresponds to the water outlet temperature. If your water has dissolved solids, this may not work due to solids precipitation and eventual plugging in the annulus. In that case, use another cooling fluid in a closed loop with indirect cooling.

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5. Are there are dangers posed in performing pneumatic pressure testing with bottled gas or is another method preferred?

****

BACKGROUND

A pipeline is be pressure tested using inert, bottled gas to raise the pressure within the process piping. The piping is not equiped with pressure relieving devices.

ANSWER

I do not recommend the use of pneumatic testing for piping or vessels within the confines of a process plant. With over 40 years of engineering experience - 10 of them in the compressed gas industry - I regard pneumatic testing as too hazardous and risky. That is my personal stand and it is based on personal field experience. I insist on the use of Hydrostatic testing of equipment, rather than pneumatic.

Let me define the two testing methods to make sure we both know what the other is talking about:
Pneumatic testing is the use of a compressible gas (usually Nitrogen or air) to fill 100% of the volume to be tested and subsequently raising the gas pressure to the test level.

Hydrostatic testing is where the internal volume to be tested is filled 100% with ambient temperature water and subsequently raising the water pressure to the test level. The means of raising the water pressure is usually done with a small, positive displacement piston pump but can be also done by imposing a compressed gas pressure (always through a 2-stage regulator) much as you have partially described. I do not recommend usage of a compressed gas source as the pressure medium for application on a hydro test.

Now, allow me to explain my recommendations.

1) You state there is no other pressure relief on the system besides the "bottle regulator". I would refer you to the fact that the pressure within the gas cylinder is many times higher than the test pressure. Otherwise, you couldn't rely on it as a source of pressue. This is also the source of the hazard! Unless you have installed a pressure relief valve downstream of the gas cylinder, there is no safety for the system. All industrial gas cylinders carry a rupture disc within the cylinder valve that is rated for protecting the cylinder - NOT YOUR PIPE OR DOWNSTREAM EQUIPMENT.

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This cylinder safety device is installed for the case where the cylinder might be exposed to fire or excessive temperatures. Unless I'm grossly mistaken or there are other facts I don't know about, you are not testing in a protected mode!

2) It is relatively very risky to test pneumatically because of the slowness of the system to relieve itself in the event of a failure. A small crack will only emit the equivalent critical flowrate (reached at sonic -or "choked"-flow) and this is usually continued to be fed upstream at the pressure source. This is the critical time when further addition of gas fluid will usually cause a massive failure of the equipment. Gas regulators are simply that; they are not pressure controllers nor can they be relied upon to react fast enough to mitigate a tragic accident. This is particularly dangerous where there are cast iron component within the tested system.

3) Testing with water, on the other hand, will be characteristically much better controlled - especially if the pressure source is an independent, small and slow rpm piston pump. Additionally, you can set the pressure relief valve on the pump's discharge slightly above the test pressure for additional safety. You will discover that a test failure within the system will result in a spontaneous liquid leak and a similarly rapid decrease in system pressure. As an added feature, you can easily trend the pressure maintenance within the system to confirm the success of the pressure tightness achieved in the system. This is considered a much safer and conservative method by most experienced engineers.

Agreeably, there is a trade-off between both methods: While being considered safer, the hydrostatic test is slower and requires a source of clean water and subsequent drainage and dryout. All of these items represent additional costs over the pneumatic test. Nevertheless, I have always opted for the hydrostatic test because I sincerely believe there is no substitute for safety.

Source: CERP Message Board, Mr. Art Montemayor

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****
6. What would be the best option for limiting or eliminating ethanol vapor emissions from storage tanks at ambient conditions?
****

BACKGROUND
Often times, ethanol plants are equipped with very old external storage tanks that contain my relief devices. Emissions from such tanks are being targeted to limit ethanol entering the atmosphere.

ANSWER
Several options exist:

1. The easy and "process-smart" answer to tankage emissions is pressurized storage; for ethanol, conventional API tank design standards allow for 2.5 psig design and this is more than ample for containing the vapors within the tank at most ranges of ambient temperatures. However, this may be a major stumbling point in your industry. The existing tanks may be very old and without calcs to put any basis on. I would strongly recommend you upgrade (as soon as you have the economic or process justification) to stainless material and a 2.5 psig design. This will make life a lot better for everyone involved. However, this may not be an immediate option ……

2. Try to get your existing tanks rated for pressurized service. Of course you need conservation vents on them, for tank protection. Rating them may be easier said than done. You may have already looked at this and discovered the futility of dealing with old, workable tanks. But this is an option nonetheless

3. Consider cooling the incoming ethanol with the coldest water you have available and store at that temperature. This lowers the storage vapor pressure and reduces the emissions. This doesn't stop the emissions; it just reduces them. This was probably the most obvious option that may have already been explored. The point here is that it is more cost effective to cool a liquid than to partially condense a saturated vapor. The disadvantage here is that you must conserve the cool liquid temperature if your ambient is appreciably higher. This calls for insulation and more maintenance.

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4. You might be able to "control" the ethanol emissions by venting through a small, continuous water scrubber and concentrating the aqueous ethanol to a level where you can recycle it back to process. This may or may not be feasible or cost effective.

5. The least attractive option, in my opinion, is putting an atmospheric vent condenser on the existing atmospheric tanks and cooling-condensing the emissions (like a "kick-back" condenser) with a refrigerant or brine. This method requires relatively expensive refrigeration equipment and controls --- with additional maintenance on equipment. Economic evaluation of this method usually shows little or no return.

Source: CERP Message Board, Mr. Art Montemayor

****

7. Where can one get a quick estimate on the size of a barometric condenser?

****

Goto the site below. These types of condenser are very popular in the sugar industry. This online calculation will even give you a nicely formatted output.

www.sugartech.co.za/rapiddesign/condenser/index.php3

****

8. What is a good correlation to estimate the density of a two-phase mixture that is mostly vapor or operating within the mist flow region?

****

Spink suggested the correlation below for qualities in the range of 0.82 to 1.0.

$$\rho_{TP} = \left[\frac{1}{X + [1.26\,(1-X)\sqrt{\rho_g / \rho_l}]} \right]^{\frac{1}{2}} \rho_g$$

ρ_{TP} = Two-phase density
X = Quality of vapor
ρ_g = Gas density
ρ_l = Liquid density

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****
9. What type of fasteners should be used with stainless steel piping?
****

There's risk of galvanic corrosion if you were to use mild steel fasteners. It's recommended to use bolts that of the same material as the piping material in this case. Another concern is that the threads on stainless steel bolts are often distorted or "galled" after being tightened and loosened a couple of times. Consider using a different stainless alloy designed with "anti-galling" characteristics for the nuts. There are also inserts available for SS nuts to prevent this as well.

****
10. How can one estimate how the friction factor changes in heat exchanger tubes with a change in temperature?
****

Seider and Tate recommended the following for determine friction factors inside heat exchanger tubes with varying temperatures:

First, determine the average, bulk mean temperature in the processing line. For example if the fluid enters the line at 300 °C and leaves at 280 °C, use 290 °C to determine the physical properties and friction factors.

As for corrections:

Laminar Flow
If the liquid is cooling, the friction factor obtained from the mean temperature and bulk properties is divided by (bulk viscosity/wall viscosity)^0.23 and for heating, it's divided by (bulk viscosity/wall viscosity)^0.38. Here, the bulk and wall viscosity are determined at the mean temperature over the length of the line.

Turbulent Flow
If the liquid is cooling, the friction factor obtained from the mean temperature and bulk properties is divided by
$(\text{bulk viscosity}/\text{wall viscosity})^{0.11}$
and for heating, it's divided by
$(\text{bulk viscosity}/\text{wall viscosity})^{0.17}$
Here, the bulk and wall viscosity are determined at the mean temperature over the length of the line.

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****
11. What are some good methods of avoiding condensation in a compressor suction line?
****

BACKGROUND
A twin lobe compressor is suffering repeated failure due to moisture in the suction line. The vapor is coming from a vertical two-phase separator

ANSWER
The liquid may be forming as the result of either:
1. Condensation in the line between the separator and the compressor.

2. Liquid carry over from the separator.

If the suction line is well insulated and/or heat traced (it probably should be), then begin with the separator. From generally accepted rules, be sure that the separator is properly sized. If the separator does not include a mesh pad, consider installing one to see if this helps. You also may want to install a mist eliminator in the line leading to the compressor (and change it at least twice a year).

If your connection into the separator is a straight connection (versus tangential), you may want to install a straight pipe that runs from the inlet to the vessel all of the way to the opposite vessel wall. This pipe should have the bottom 40% cut out. The downward entry motion will help give additional separation of the vapor from the liquid. You can see such a pipe in the graphic below.

****
12. What is an air knife?
****

An air knife is device that is used for drying surfaces of liquid (usually water). It works by pushing the bulk of the liquid along of the surface being dried via an air stream. Residual film moisture is then atomized by the force of the air and the surface is left very dry. Air knives can also be used to remove solid particles from surfaces as well.

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****
13. What can cause bulk solids to stop flowing from a bin?
****
Causes of such problems can fall into one of two categories:

Material strength or Bin Geometry:

Factors that can affect material strength include:
1. Moisture-especially with particles which fuse together with moisture. (i.e. cement, salt, sugar)
2. Particle shape
3. Cohesiveness
4. Static Charge
5. Elastic Springback
6. Cycling of Temperature from hot to cold (see item 1)

The bin geometry can also have adverse affects on the ability of bulk solids to flow. Characteristics that are undesirable include:

1. Square corners
2. Shallow hopper slopes
3. Non-movement of material along walls

****
4. How can one determine if a particular solid can be fluidized as in a fluidized bed?
****
Mr. Alex C. Hoffmann of the Stratingh Institute for Chemistry and Chemical Engineering states:
"Whether a material can be fluidized at all is the question: if it is fine or sticky, the bed will be cohesive. It will then tend to form channels through which the aeration gas will escape rather than being dispersed through the interstices supporting the particles. In the other extreme: if the particles are too large and heavy the bed will not fluidize well either, but tend to be very turbulent and form a spout."

He goes on to present classification of fluidization by Geldart by use of the chart shown below. On this chart, the x-axis is the average particle diameter and the y-axis is the bulk density of the bed.

(image on next page)

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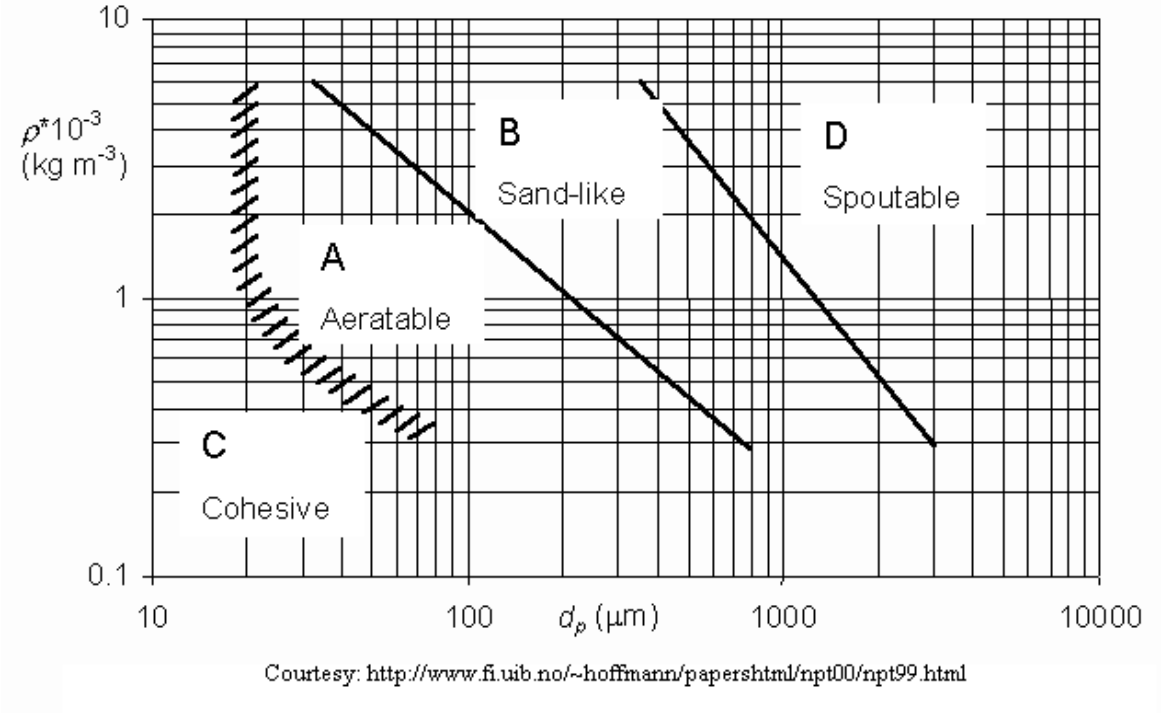

Courtesy: http://www.fi.uib.no/~hoffmann/papershtml/npt00/npt99.html

****

15. How can VOCs (volatile organic compounds) be recovered from beds of activated carbon?

****

The use of activated carbon is a popular method of removing volatile organic components from air streams. Typically, these spent carbon beds are either sent back to the manufacturer and fresh beds are used or the carbon is regenerated by using steam to destroy the VOC within the carbon bed.

Another, more recent, technology related to vapor phase carbon absorption is the Brayton-cycle heat pump (BCHP). This technology created by Idaho National Engineering Laboratory offers a method for VOC recovery and recycling. A Brayton-cycle heat pump can condense volatile organic compounds (VOCs) from an air stream, which offers the potential for both recovery and either on-site or off-site recycle of a wide range of VOCs.

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The VOC-laden air stream can come from either vapor vacuum extraction of soil or air stripping of contaminated ground water. A truck-mounted BCHP is used to regenerate the adsorbers on a periodic basis. When the bed becomes saturated, hot nitrogen from the regenerator is used to desorb the VOCs from the bed. The nitrogen passes through a chiller, is compressed, and is then cooled in a recuperator, where 50% to 80% of the organics are recovered. The partially depleted nitrogen stream is then expanded through a turbine, lowering the temperature to as low as -150oF and condensing the remaining organics. The now-clean nitrogen passes through the recuperator to cool the VOC-laden nitrogen before returning to the carbon bed. The only outputs will be the clean off-gas and a small amount of recovered organics.

The economics of such a system are not available at this time. This system has been employed in a system where air was used to strip VOCs from groundwater. The VOC-laden air was then sent to the carbon beds and the BCHP system was used to recover the contaminants.

****

16. What is an effective method of measuring flow in flare lines?

****

Orifice plates, a natural first choice, are generally not suitable for this service. The reason is that the the flare line is always sized for the maximum possible flare flow in an upset condition. The flow to the flare under normal conditions will be smaller by a factor of 100 to 1000. The pressure drop across the orifice under normal conditions will not be high enough to permit accurate flow measurement.

There have been many attempts to find a suitable flowmeter for this service. Utrasonic flowmeters have consistently performed well. They also provide the advantage of having no obstruction in the line. The best-known supplier is Panametrics. They have an excellent reference list in refineries and chemical plants. The only disadvantage is the cost - on the order of $30,000 per installation.

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****
17. What are some possible causes of corrosion in line of heavy naptha from crude tower?
****
Some possibilities could include:
A. water trapped in the line due to a deadleg or low spot which can not drain.
B. B. if processing high naphthenic acid crudes, perhaps the neutralization number is high in the heavy naphtha fraction, although this would be unusual. Test the stream neutralization number.
C. stream temperature too cool and condensing salts out in the line.

****
18. What is an effective means of removing silicon from aluminum?
****
Silicon is well known for its chemical inertness, (ie. it tends to not react with many other chemicals). Depending on what type of silicon your dealing with, this may or may not be easy to solve. If the silicon is from a lubricant, it's probably the graphitic form which is soluble in a strong combination of nitric and hydrofluoric acids, neither of which I would recommend for you to use...and hydroflouric acid is not easy to come by. If it's silicon from an acidic form (probably any other form other than a lubricant), you should try ammonia. In either case, leave your acetone at home...it will NEVER work!
UPDATE:
An ammonia solution worked very well in this case

****
19. Are there any commercial routes to phenol other than the traditional reaction using cumene?
****
Solutia Inc. reported the construction of a plant in Pensacola, FL that utilizes a one-step catalytic oxidation of benzene with nitrous oxide. Solutia claims that this pathway significantly reduces aqueous waste and does not produce acetone as a by-product.

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****
20. How does particle size affect the appearance of an oil emulsion in water?
****
For very large or macro molecules, to distinct phases will be present. For particles greater than 1 micron in size, the emulsion will appear milky white. Particles ranging from 0.10 to 1 micron will appear blue-white. Emulsions with particles ranging from 0.05 to 0.10 microns will take on a gray or even semi-transparent look. Particles less than 0.05 microns in diameter will produce a transparent microemulsion that can have three or more phases.

****
21. Is there any way to slow coke formation in ethylene furnaces?
****
Westaim Corporation has a commercial process for applying a special coating to the tubes used in ethylene furnaces. Westaim claims that coke buildup is reduced to one-forth to one-tenth of the normal rate. The coating consists of a combination of metal, ceramic powder, and a polymer. Once the coating is applied, the tubes are then heat treated and reacted with an unspecified gas. Welds cannot be coated with this process.

****
22. How are vessel lined with glass or how are they coated?
****
First, the glass mixture is smelted for form the proper recipe based on temperature and pressure requirements of the vessel. Then the glass is ground into tiny particles and suspended in a liquid medium called a slip. This mixture is then spayed onto the surface to be coated. The vessel is then heated to about 800°C to bond the glass to the steel (usually carbon steel). The vessel is then slowly cooled.

****
23. Are there any general rules that should be considered when designing a slurry piping system?
****
The following are items to consider when designing a piping system that will transport slurries:

Whenever possible, piping should be designed to be self draining
Manual draings should be installed to drain sections of the piping when self draining is not possible.

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Blow-out or rod-out connections should be provided to clear lines in places where plugging is likely or could occur.
Access flanges should be provided at T-connections.
Manifolds should have flanged rather than capped connections to allow for easy access.
Clean-out connections should be provided on BOTH sides of main line valves so that flushing can take place in either direction.
Break flanges should be provided every 20 feet of horizontal pipe or after every two changes in direction.

****

24. Are there flow velocity restrictions to avoid static charge build up in pipelines?

****

One such standard that is utilized in Australia (AS1020 (1984) - Control of undesirable Static Electricity) give the following velocity limitation for flammable hydrocarbons:

Pipe Size (mm)	Velocity (m/s)
10	8
25	4.9
50	3.5
100	2.5
200	1.8
400	1.3
600	1.0

****

25. Where can I find more information on the thermal design of boilers?

****

Although the design of the site leaves much to be desired, it's full of really good information on the thermal design of boilers:

http://members.tripod.com/vganapathy/boilers.html

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****
26. How does a tank blanketing valve operate?
****

According to Protectoseal (a leading supplier of such valves):

"Tank Blanketing Valves provide an effective means of preventing and controlling fires in flammable liquid storage tanks. Vapors cannot be ignited in the absence of an adequate supply of oxygen. In most instances, this oxygen is provided by air drawn into the tank from the atmosphere during tank emptying operations.

Tank Blanketing Valves are installed with their inlet connected to a supply of pressurized inert gas (usually Nitrogen), and their outlet piped into the tank's vapor space. When the tank pressure drops below a predetermined level, the blanketing valve opens and allows a flow of inert gas into the vapor space. The blanketing valve reseals when pressure in the tank has returned to an acceptable level. The blanketing gas contains no air. No supply of air (Oxygen) is allowed to enter the tank. The vapors, therefore, never form a flammable mixture."

Source: Protectoseal, www.protectoseal.com

****
27. What steps can be taken to avoid stress corrosion cracking (SCC) in steel vessels used for storing anhydrous ammonia?
****

The U.S. National Board of Pressure Vessel Inspectors recommends the following in one of their classic articles:

A. Pressure vessels should be either fully stress relieved or fabricated with heads that are hot-formed or stress relieved.

B. Extreme care should be used to eliminate air from the ammonia systems; new vessels must be thoroughly purged to eliminate air contamination.

C. Ammonia should contain at least 0.2 percent water to inhibit SCC.

Reference: National Board of Pressure Vessel Inspectors
Note:
Entire Classic Article Series is available at:
www.nationalboard.org/Classics/articles.html

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****
28. Why is it important that the moisture content of natural gas be minimized?
****
Excess moisture in natural gas pipelines can cause the following problems (there are others):

A. As the gas passes through regulators and valves, it will experience a pressure drop and a subsequent temperature drop. Any moisture can freeze and result in blockages.

B. Light gases can form hydrate compounds in the presence of water. These hydrate compounds can also represent a blockage danger.

C. The carbon dioxide and/or H2S can form corrosive agents if allowed to mix with water.

D. Excess moisture can greatly reduce the heating value of the natural gas.

E. Liquid slugs can form and pass through separators and severally damage compressors.

Reference: APK Engineers, U.K.

****
29. What is a good device to use for obtaining viscosity data for a non-newtonian fluid?
****
Consider a rotational viscometer. It will measure the shear rate applied and the subsequent viscosity at the same time. You can also vary the temperature and time the stresses are applied for the truly "fun" non-newtonian fluids.

According to Cole-Parmer (a manufacturer of these devices):
"The rotational viscometer measures viscosity by determining the viscous resistance of the fluid. This measurement is obtained by immersing a spindle into the test fluid. The viscometer measures the additional torque required for the spindle to overcome viscous resistance and regain constant speed. This value is then converted to centipoise and displayed on the instrument's LCD readout."

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When testing a tomato sauce sample, the following results were observed: "A sample of tomato sauce was analyzed to determine the product's viscosity profile. The test was conducted at a temperature of 25°C. An up/down speed ramp was performed from 10 to 100 RPM, giving a viscosity range of from 3,800 to 632.5 cP, over shear rates from 3.4 to 34.0 reciprocal seconds. The test data obtained for tomato sauce shows that this product exhibits a marked shear thinning viscosity profile over the test conditions."

Reference: Cole-Parmer

****

30. What types of options do refiners typically evaluate to reduce carbon dioxide emissions?

****

There are three basic ways to reduce carbon dioxide emissions to the atmosphere in a refining environment:

1. Remove Prior to Emission or "End of the Pipe" options where the carbon dioxide is removed by one of many different separation techniques from the gases emitted. These can include both chemical and/or physical separation techniques.

2. A second option involved the reduction of the production of carbon dioxide by integrating processes using pinch analysis tools, waste heat recovery, and other efficiency increasing techniques.

3. The third option is to radically change the way the feedstocks are processed or the "alternate route" method. Obviously, this method must prove to be economically competitive with conventional routes to be employed.

Reference: Foster Wheeler Company

****

31. What's a good method to clean a boiler?

****

One of the following solutions can be used to clean a boiler:

Trisodium Phosphate, 1 kg for 420 L (1 lb for 50 gal) in the system
Sodium Carbonate, 1 kg for 240 L (1 lb for 30 gal) in the system
Sodium Hydroxide, 1 kg for 420 L (1 lb for 50 gal) in the system

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The system should be filled and vented. Circulate the solution throughout and allow the system to reach operating temperature if the material of construction (with the cleaning solution in contact) will permit it. After the solution has been circulating for a few hours, drain the system and refill with fresh water. Usually, enough of the cleaner will adhere to the piping to give an alkaline solution satisfactory for operation. A pH reading between 7 and 8 is preferred, and a small amount of cleaner can be added if necessary.

Reference: Standard Handbook of Plant Engineering, Robert Rosaler

****

32. What is a good rule-of-thumb to determine when a particular application should utilize a metallic gasket rather than a non-metallic gasket?

****

As a guideline, check the following values for your application:
--English Units--
Operating Pressure (psig) x Operating Temp (°F)
If this value exceeds 250,000, you should strongly consider a metallic gasket.

--Metric Units--
Operating Pressure (MPa) x (1.8 x Operating Temp (°C) + 32)
If this value exceeds 1,720, you should strongly consider a metallic gasket.

Additionally, many people will seldom use non-metallic gaskets above 450 °C (850 °F) or above pressures of 8.3 MPa (1200 psi).

****

33. How is HCl produced?

****

Interesting question....most hydrochloric acid isn't "produced" on purpose. It's usually a by-product of many, many different chlorination processes used in the chemical processing industry. In the United States, a stagering 90% of the HCl capacity comes from by-products while only about 10% of the capacity results from the burning of H2 and Cl2 to form HCl gas. The resulting gas is then absorbed into water to produce acid.

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The "intentional" production process is used widely in other parts of the world. The reaction is completed around 200 °C (392 °F) and the resulting gas can reach 99% HCl purity. The absorption with water is accomplished in a column made of tantalum or graphite. The absorption gives off about 1625 kJ/kg of HCl gas absorbed. This heat must be removed by the adsorber for efficient operation.

****

34. How can one determine the upper and lower explosive limits of hydrocarbon mixtures?

****

LEL =(V1 + V2 + ... Vn)/(V1/lel1 +V2/lel2 + ... Vn/leln)

V1 - vol fraction of first component
lel1 - lower explosive limit of component 1

UEL =(V1 + V2 + ... Vn)/(V1/uel1 +V2/uel2 + ... Vn/ueln)

V1 - vol fraction of first component
uel1 - upper explosive limit of component 1

Source: "Explosions" by Springer-Verlag, Berlin Heidelberg, New York

****

35. What is a good way to debottleneck a chemical water treatment facility?

****

Most waste water facilities attached to chemical processing facilities were designed to use air as a means of dissolving oxygen into the water. The air used by aerobic agents to break down the unwanted compounds in the wastewater.

By substituting pure oxygen for air injection, the amount of dissolved oxygen in the water can be increased five time over what is typically possible by using air. This additional oxygen speeds the treatment process and can significantly increase the capacity of a waste water facility. So much additional capacity can be realized that some companies have avoiding the construction of additional facilities by adding pure oxygen introduction to their facility.

Reference: Chemical Engineering Magazine, January 2001

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****
36. How is a multiple effect evaporation system usually controlled?
****

It's common to use an online density transmitter or a online viscometer measuring the product stream leaving the station.

The instrument will first measure the density (or viscosity) at the process temperature and then compute the density (or viscosity) at a reference temperature. This value may then be used to compute the outlet concentration. This can be output as a 4-20mA for input to the controller.

The control variable is often time the steam flow to the sytem, but can also be the feed liquor rate or other variables (such as the vacuum source).

****
37. What are the typical operating ranges of filter presses?
****

Filter presses are capable of handling fine solids are varying flow capacities. A couple of limits to consider may be:

Up to 30% solids for flows up to 1 GPM
Up to 10% solids for flows up to 10 GPM
Up to 1% solids for flows up to 100 GPM
Up to 100 ppm solids for flows up to 500 GPM

The chart shown below is helpful in understanding this and the operating ranges of some other types of filtration methods.

Operating pressures of 100 psi are common, but 1000 psi is possible in some case. No specific information was available on the particle sizes that can be processed, but fine, powder particles are the most common.

(Image on next page)

Reference: FDS Filters, www.fdsfilters.com

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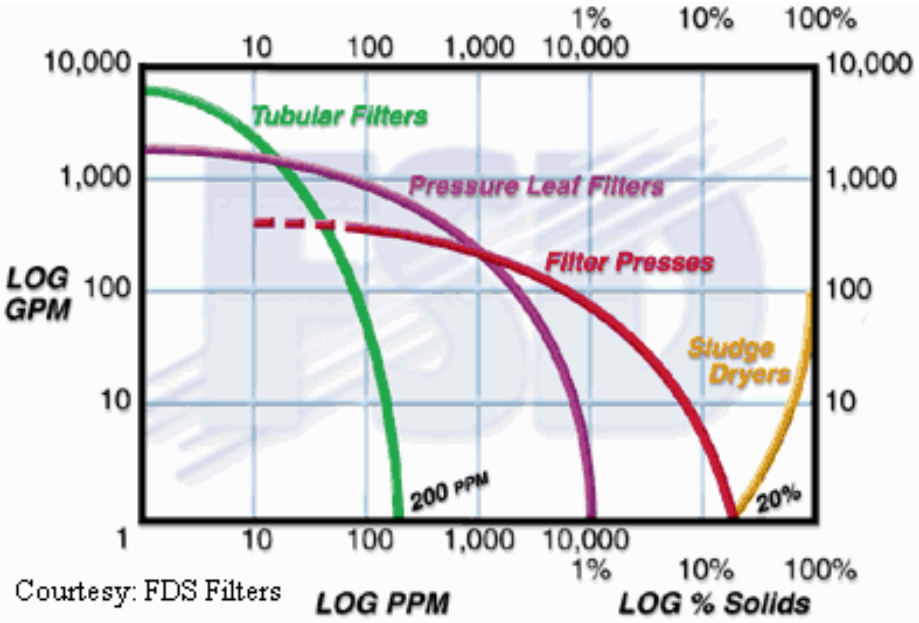

****

38. What is the most common cause of solid size segregation in bulk solid systems?

****

Many engineers usually point directly to the pneumatic conveying system as a source of such a problem. The truth is that in most cases, segregation occurs as a result of the differences in sizes of the particles.

As a rule-of-thumb, if the size ratio extends outside of around 1:1.3, then there will most likely be segregation. This being said, one should inspect the equipment responsible for determining the particle size rather than the pneumatic conveying system if this problem is occuring.

Reference: Richard Farnish, The Wolfson Centre for Bulk Solids Handling Technology

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****
39. What options are available for ammonia-on-demand systems to supply selective catalytic reduction systems?
****

Several companies have technology that utilize urea as a means to power an ammonia-on-demand (AOD) system.

Two such companies are Hamon Research-Cottrell (research-cottrell-us.com) and Environmental Elements Corporation (www.eec1.com).

The reason for this process is to avoid having to transport ammonia from one site to another. Most of these systems work via the hydrolysis of urea. Urea is dissolved in water and heated to about 148 °C (300 °F) at a pressure of about 6.8 bar (100 psig). As of 2001, capital cost for such a system where estimated at around $1000 USD / lb / h for a plant to produce up to 3,000 lb/h of ammonia.

****
40. What are some of the advantages and disadvantages of cleaning process equipment by cleaning-in-place (CIP)?
****

Cleaning-in-place (or CIP) is a popular method of cleaning process equipment in many parts of the world. With the exception of food and pharmaceutical industries, CIP has largely failed to catch on in the United States however.

CIP is a very viable method of cleaning many different types of chemical processing equipment, particularly those with reasonable volumes.

Advantages include:
1. Repeatable cleaning results
2. Measurable and recordable cleaning results
3. Reduced operator exposure to the processing and cleaning fluids.
4. Decreased cleaning time (in most instances)
5. Ability to use more agressive cleaning solutions
6. Reduced equipment wear

Disadvantages include:
1. Initial capital costs of system
2. Purchase and disposal of cleaning solutions
3. Absence of a visual inspection of the internal equipment surfaces

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****

41. What technologies are commonly employed to purify hydrogen from a reforming unit?

****

There are three (3) commonly used technologies to purify hydrogen from reformers. The determination of which one to use depends on a number of factors.

If the hydrogen must be 99% by volume pure, then Pressure Swing Adsorption (PSA) is the most common choice. The other two technologies are rarely capable of this purity. Instead, they're generally able to reach 95-98% by volume purity.

If the purity required is in the range of 95-98% by volume and the feed gas is at a pressure of 2-5 times that required for the product hydrogen stream, then membrane separation can be employed. Obviously the pressure loss in such a system is substantial.

If the feed gas stream contains substantial byproducts that are to be recovered and a hydrogen purity of 95-98% by volume is acceptable, then a cryogenic unit is a good choice. Byproducts can be recovered from PSA unit off-gases but the low pressure at which this stream is available often make byproduct recover uneconomical.

Another consideration is the capacity of the product hydrogen stream. PSA units are built for 5-100 MMscfd of hydrogen. PSA units and cryogenic units have excellent economies of scale for large capacities. Membrane units are generally a better option for smaller capacities.

Reference: Hydrocarbon Processing Magazine, February 2003

****

42. Is there a company out there that has extensive knowledge and experience in pumping sulfuric acid and molten sulfur?

****

One such company with vast experience with both of these applications is Lewis Pumps in St. Louis, Missouri in the United States. They had experience in both applications utilizing their vertical-style pumps.

You can find out more about these pumps and their applications at www.lewispumps.com.

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****
43. What is a common failure mechanism for above ground atmospheric storage tanks?
****

Tanks constructed prior to the 1950's are notorious for failing along the shell-to-bottom seam or on the side seam. The principle reason for this is that these tanks were constructed before there were established procedures and codes for such a tank (Ex/ API-650 "Welded Steel Tanks for Oil Storage").

One of the key features of these codes and procedures was to make sure that tanks were designed to fail along the shell-to-seam such that the liquid remained largely contained.

You can read more about this topic by downloading the publication entitled "Catastrophic Failure of Storage Tanks" from the U.S. Chemical Emergency Preparedness and Prevention Office (see link below)

http://www.cheresources.com/Uploads/cattanks.pdf

****
44. What is a good method of cleaning a crude tower?
****

Here is a typical progression:

A. Steaming: The steaming is done after all liquid hydrocarbons have been drained from the column and associated piping. The objective of steaming is to make the column and associated piping free of residual hydrocarbons. The column vent and pump strainers in the side draw piping are de-blinded and steaming is started from utility connections at the bottom of the column. Generally, steaming is continued for about 20 to 24 hrs, ensuring the column top temperature remains more than 100 °C throughout the operation.

B. Hot Water Washing: When clear steam is observed exiting the column vents, water washing of the column should be started. With steam still in commission, water is sent to the column, usually via reflux lines, and it is drained from the column bottom, associated pump strainers, etc. The water flow rate should be adjusted so that steam still comes from the vent (i.e. water should not result in condensing of all steam before it reaches the column top). Water flow should be stopped for 2-3 hrs and then resumed.

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This cycle of steaming and washing should be repeated several times for a total of about 15 to 20 hours. Injection of a turpene-based detergent into the steam can also be considered. The condensate-soap solution can be collected and circulated through the various side cuts.

C. Blinding: When clear water is observed at side draw pump strainers, etc., associated piping should be isolated by installing blinds wherever isolation is possible.

D. Cold Water Washing: The hot water wash should be followed by a cold water wash (i.e. steam should be fully closed). The cold water washing is done for about 20-24 hrs.

E. Chemical Injection for Removal and Neutralization of PIS Deposits: During the cold-water wash or after washing is over, chemical injection for removal of pyrophoric sulfides should be considered. The various options for chemical treatment are discussed below:

Acid cleaning - This procedure involves pumping in an acid with some corrosion inhibitor. The acid dissolves sulfide scale and releases hydrogen sulfide gas. It is effective and inexpensive, however, disposal of hydrogen sulfide gas can be a problem, as can corrosion (when the system contains more than one alloy). Dilute hydrochloric acid solutions may also be used. The resulting iron chloride turns bright yellow, acting as an indicator for removal of the iron sulfide.

Acid plus hydrogen sulfide suppressant - Additional chemicals can be added to the acid solution to convert or scrub the hydrogen sulfide gas.

Chelating solutions - Specially formulated, high pH, chelating solutions are quite effective in dissolving the sulfide deposits without emitting hydrogen sulfide, but this is an expensive application.

Oxidizing chemicals - Oxidizing chemicals convert sulfide to oxide. Potassium permanganate ($KMnO_4$) has been used commonly in the past to oxidize pyrophoric sulfide. Generally the potassium permanganate is added to the tower during the cold water washing as a 1% solution. At various intervals, samples are taken and checked for color. The colors of the fresh $KMnO_4$ and the spent MnO_2 are purple and brown respectively. If the color of the solution becomes brown, additional $KMnO_4$ is needed. The reaction is judged complete when the solution color remains purple. It takes approximately 12 hours to complete the job.

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In recent times, the use of potassium permanganate as an oxidizer has raised serious safety and health concerns. A very good alternative to explore is the use of a cleaning agent called Zyme-Flow from United Laboratories (see link below).

Zyme-Flow Website: www.zymeflow.com

Reference: Pryophoric Iron Fires, www.cheresources.com/ironfires.shtml

****
45. What is glucosamine and how is it made?
****

Glucosamine is a "nutraceutical" amino sugar with worldwide retail sales approaching $1 billion (USD). It's called a "nutraceutical" because it's used for health purposes, but it's not regulated like a drug. It's commonly used for the treatment of arthritis because it's believed to be able to promote the formation and repair of cartilage.

The most common production method is via the acid hydrolysis of chitin (a polysaccharide found in crab shells). Essentially, the raw material is simply boiled in hydrochloric acid, then the product is crystallized out. This market has been primarily dominated by China. Other countries have found it difficult to compete due to the price of hydrochloric acid and the cost of waste treatment.

A more promising route to glucosamine is via the use of microbial fermentation. Two companies (Bio-Technical Resources and Biopolymer Engineering Inc.) have such processes operating on world scale size plants. More details of this new process are available via U.S. Patent #6,372,457.

Bio-Technical Resources website - www.biotechresources.com
US Patent Search - patft.uspto.gov/netahtml/srchnum.htm

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****
46. Are there any methods of preventing cracking of carbon steel welds in refining environments?
****

Where carbon steel is an appropriate material of construction, NACE (National Association of Corrosion Engineers) has issued the following standard:

NACE RP0472, "Methods and controls to prevent in-service environmental cracking of carbon-steel weldments in corrosive petroeum refining environments."

For welds where hardness testing is required, RP0472 give the following guidelines:

A. Testing shall be taken with a portable Brinell hardness tester. Test technique guidelines are given in an appendix in the standard.

B. Testing shall be done on the process side whenever possible.

C. For vessel or tank butt welds, one test per 10 feet of seam with a minimum of one location per seam is required. One test shall be done on each nozzle flange-to-neck and nozzle neck-to-shell (or neck-to-head) weld.

D. A percentage of helping welds shall be tested (5 percent minimum is suggested).

E. Testing of fillet welds should be done when feasible (with the testing frequency similar to the butt welds).

F. Each welding procedure used shall be tested.

G. Welds that exceed 200 Brinell shall be heat treated or removed.

Reference: Chemical Processing, May 2001

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****
47. What are some uses for Manganese Chloride (MnCl2)?
****

Manganese chloride is used for the dyeing textiles, as a disinfectant, and as a component in dry cell batteries. It's also used as a catalyst for some chlorination reactions.

Additionally, manganese chloride is used to produce various manganese salts including methylcychlopentadienylmanganese tricarbonyl which is in turn used as a colorant for bricks.

In it's raw state, manganese chloride is a pink solid which melts at around 650 °C (1200 °F)

****
48. What are some common problems associated with bellow expansion joints?
****

Bellow expansion joints have (in some circles) gained a reputation for being "weak" points in piping. Usually they're used to remove piping stresses from equipment or to allow for minor piping moments.

If they're used properly, expansion joints can save equipment and/or equipment welds from stresses generated from piping forces.

The two most common complaints about bellows are:
A. They tend to build up dirt
B. They are "weak" point in piping (as noted earlier)

To overcome these issues, manufacturers began installing drains in the bellows to allow for the periodic purging of material. Additionally, bellow manufacturers have placed much emphasis on installation advice and showing their customers how to protect the bellow from unnecessary damage. One such method is the use of tie rods between the end flanges to avoid pressure thrust movements (beyond the bellow's design conditions) which are often the cause of bellow failures.
If you want to learn more about bellow installation or participate in online conversations about bellows, check out the following websites:
Expansion Joint Systems, Inc.
www.ejsus.com
Online Expansion Joint Forum
www.pipingtech.com/cgi-bin/ubb/forumdisplay.cgi?action=topics&forum=Expansion+Joints&number=6

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****
49. When is it necessary to use a pump that complies with API-610?
****

The American Petroleum Institute has standards for pumps that generally apply to a service for toxic, flammable, or explosion-prone services where one or more of the following conditions are expected:

A. Head exceeds 350 ft (106.6 m)
B. Temperature of fluid exceeds 300 °F (149 °C) on pumps with discharge flanges larger than 4 in. or 350 °F (177 °F) on pumps with 4 in. or smaller discharge flanges.
C. Driver horsepower exceeds 100 hp (74 kW)
D. Suction pressure is in excess of 75 psig (516 kPa)
E. Rated flow exceeds flow at best efficiency point (BEP)
F. Pump speeds in excess of 3,600 rpm.

While these are not "hard and fast" rules, they are used as guidelines.

Reference: Improving Machinery Reliability, Gulf Publishing, ISBN 0884156613

****
5. What are the advantages and disadvantages of using gear pumps?
****

Gear pumps are a type of positive displacement pump that are appropriate for pumping relatively high pressures and low capacities.

Advantages include the ability to handle a wide range of viscosities, less sensitivity to cavitation (than centrigual style pumps), relatively simple to maintain and rebuild.

Disadvantges can include a limited array of materials of construction due to tight tolerances required, high shear placed on the liquid, and the fluid must be free of abrasives.

Also note that gear pumps must be controlled via the motor speed. Throttling the discharge is not an acceptable means of control.

Reference: The Pilot Plant Real Book, FXM Engineering, ISBN 0972176918

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