Session 4: Gas Dehydration – Part 2

Prepare to Teach

Session Overview

Session 4 continues a comprehensive overview of gas dehydration. Students are introduced to relevant concepts, equipment and procedures. Students are also introduced to applicable health, safety and environmental issues.

Class Preparation Checklist

- ☐ Review the homework assignments issued during the last sessions.
- ☐ Make copies of handouts (see Appendix).
- ☐ Arrange for flipchart easel, flipchart paper, and markers OR whiteboard and markers.
- ☐ Arrange for overhead projector and overheads, if used.
- ☐ Ensure Video*: Glycol Dehydrators* (Part 1) has been obtained from PETEX.
- ☐ Bring texts or other materials to be used in this course.
- ☐ Identify and list local Engineering Companies to assist in segment #13 and/or the homework assignment for this session.

Learning Objectives

1. Describe the activities associated with monitoring and regulating the dehydration process.
2. Describe the activities associated with maintaining dehydration process performance.
3. Describe the dehydration process maintenance activities performed by the production technician.
4. Explain the typical malfunctions associated with dehydration systems.
5. Discuss the safety systems associated with the dehydration process.

6. Describe the safety, health and environmental concerns associated with working with dehydration process.
7. Compare and contrast the major differences in dehydration systems between onshore and offshore facilities, as well as between various regions within the United States.

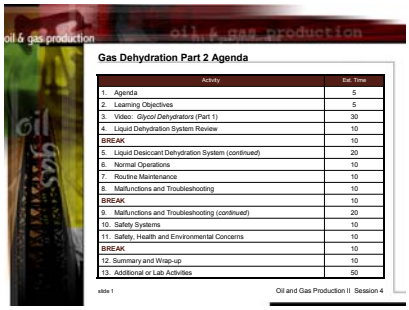
Agenda

Activity	Estimated Time
1. Agenda	5
2. Learning Objectives	5
3. Video: *Glycol Dehydrators* (Part 1)	30
4. Liquid Desiccant Dehydration System *(review)*	10
BREAK	10
5. Liquid Desiccant Dehydration System *(continued)*	20
6. Normal Operations	10
7. Routine Maintenance	10
8. Malfunctions and Troubleshooting	10
BREAK	10
9. Malfunctions and Troubleshooting *(continued)*	20
10. Safety Systems	10
11. Safety, Health and Environmental Concerns	10
12. Summary and Wrap-up	10
BREAK	10
13. Additional or Lab Activities	50

Begin Lesson

1. Agenda

Time: 5 minutes

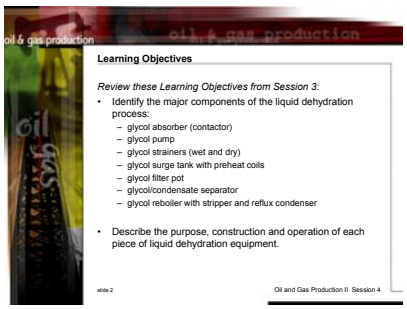


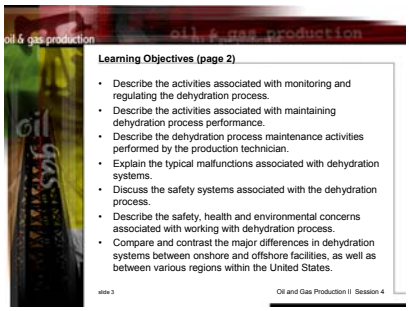
Show Slide 1:
Gas Dehydration Part 2 Agenda

- Using the transparency, whiteboard, or flipchart, list the topics that you intend to cover in the class today.

2. Learning Objectives

Time: 5 minutes



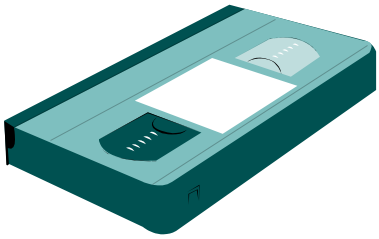


Show Slide 2 and 3:
Learning Objectives

- Discuss the lesson objectives with the learners in order to provide them with clear guidelines for what is to be learned during the instructional session.

3. Video: Glycol Dehydrators (Part 1)

Time: 30 minutes



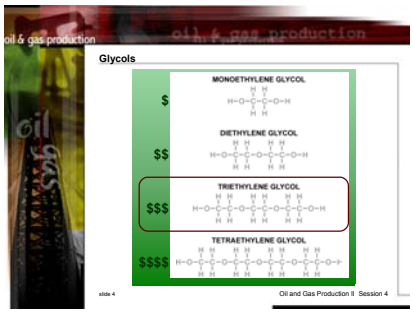
Video:
***Glycol Dehydrators* (Part 1) – PETEX 55.1171**

- Draw analogies as #4 below is presented so that the video information can be brought in today's production environment.

4. Liquid Desiccant Dehydration System (Review)

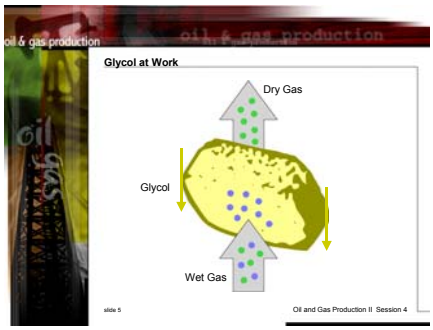
Time: 10 minutes

- Proceed ***quickly*** through the slides in this section as a review of the session information on Liquid Desiccant Dehydration from last week.
- Have students pull out previous session notes for reference during this session (especially the labeled liquid desiccant system component identification and the schematic Drawing ID# PFD-GENERIC-06 entitled ***Glycol Dehydration/Gas Processing Process Flow***).



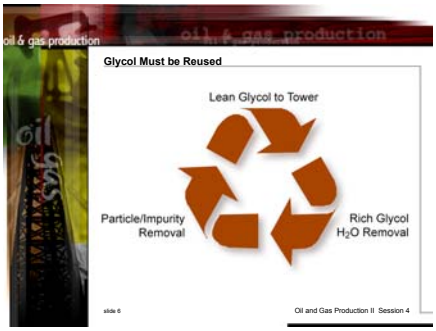
Show Slide 4:
Glycol Heated in Reboiler

- A liquid desiccant dehydration system utilizes the water absorbing properties of a family of liquid chemical called glycols.



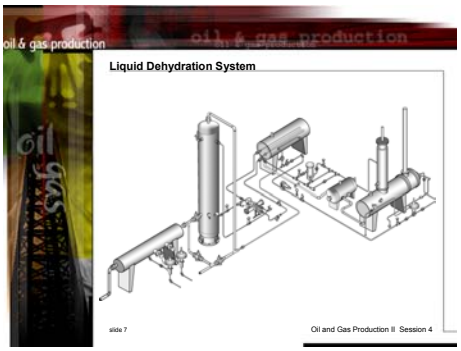
Show Slide 5:
Glycol At Work

- Glycol acts like a sponge to remove water vapor from produced gas.



Show Slide 6:
Glycol Must Be Reused

- Glycol is too expensive to be used once and then disposed. Wet glycol must be treated so it can be reused. This explains the complexity of a liquid desiccant dehydration system.

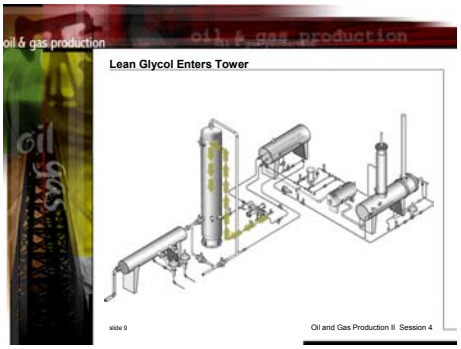


Show Slide 7:
Liquid Desiccant Dehydration System

- A discussion was begun in the last session regarding the circulation of gas and glycol through this system.

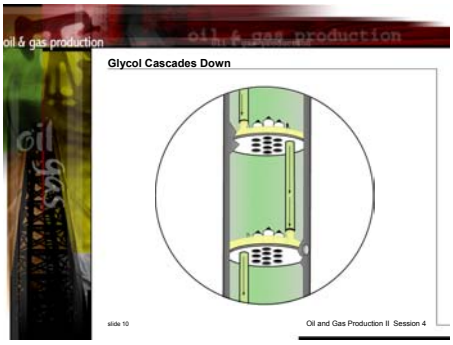
Show Slide 8:
Wet Gas Enters the Absorption Tower

- Wet gas goes through the separator and then enters the bottom of an absorption tower.



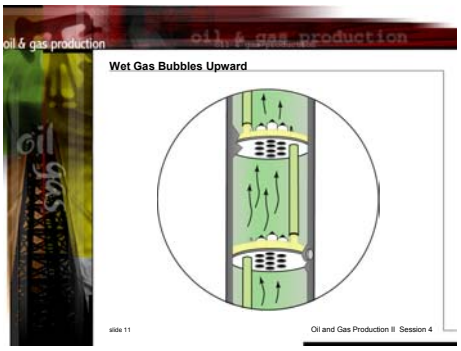
Show Slide 9:
Lean Glycol Enters Tower

- Lean glycol is pumped into the top of the absorption tower.



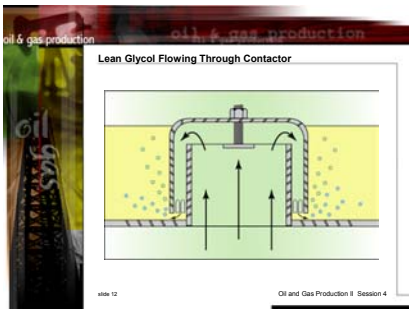
Show Slide 10:
Glycol Cascades Down

- Inside the tower, the glycol cascades down a series of levels (trays).



Show Slide 11:
Wet Gas Bubbles Upward

- The wet gas rises and *bubbles up* through each level (tray) of flowing glycol.

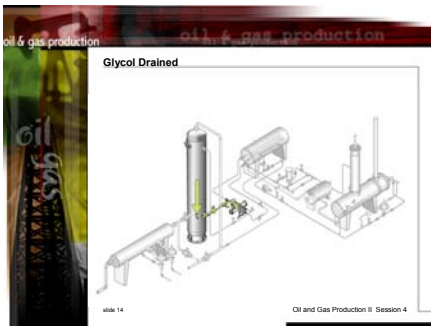


Show Slide 12:
Lean Glycol Flowing Through Contactor

- Bubble caps on each level allow the gas to pass upward without allowing the glycol to pass through. The glycol drains down through tubes called *downcomers*.

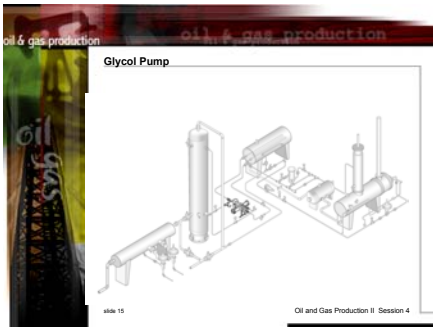
Show Slide 13:
Dry Gas Outlet

- The gas (now dry) flows out the top of the contactor for further treatment.



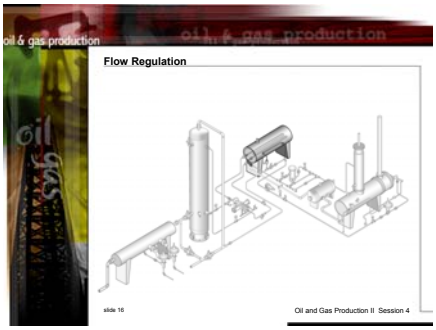
Show Slide 14:
Glycol Drained

- The glycol, now a water-rich solution, is dumped from the bottom.



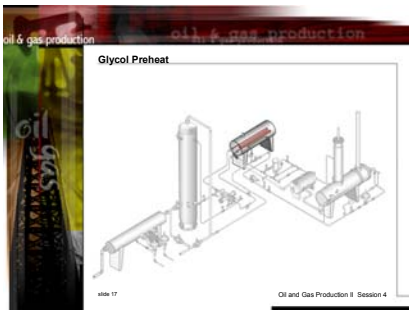
Show Slide 15:
Glycol Pump

- The water-rich glycol is pumped through the glycol surge tank/heat exchanger.



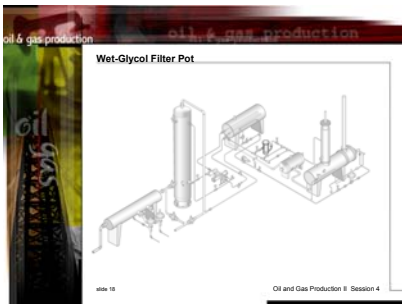
Show Slide 16:
Flow Regulation

- The surge tank helps to regulate the glycol level in the reboiler to minimize fire tube damage due to a low glycol level.



Show Slide 17:
Glycol Preheat

- The surge tank also contains preheat coils. These coils are used to begin the process of heating the glycol.



Show Slide 18:
Wet Glycol Filter Pot

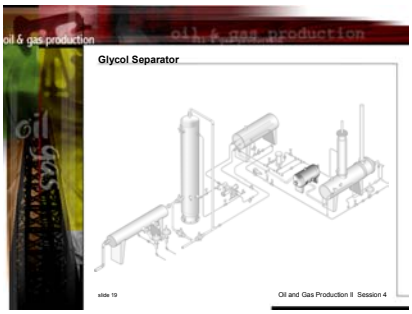
- From the surge tank, the glycol is dumped through a wet–glycol filter.
- The filter removes particulates and other impurities from the glycol.

Break 10 minutes

5. Liquid Desiccant Dehydration System *(continued)*

Time: 20 minutes

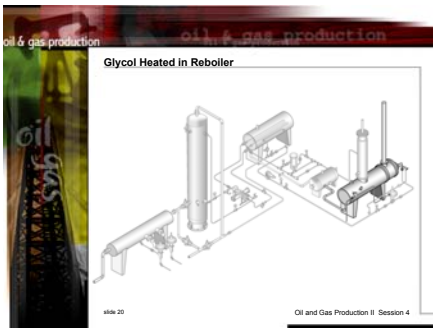
NOTE: The following material is new to students and requires more explanation.



Show Slide 19:
Glycol Separator

- After passing through the wet-glycol filter, the glycol enters a three-phase gas (1)/glycol (2)/ condensate separator (3).

  NOTE: The purpose of this system component is to remove the major portion of gas/condensate trapped in the glycol before the glycol enters the reboiler.



Show Slide 20:
Glycol Heated in Reboiler

- From the gas/glycol/condensate separator, the wet glycol flows into the reboiler.
- A burner fires a gas flame into the fire tube in the bottom of the vessel.
- A wire mesh protective barrier called a flame arrestor allows air to flow into the fire tube while confining the flame within the tube.
- The wet glycol is heated until the water content boils and turns into steam.

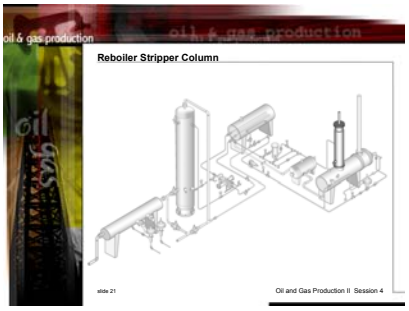
  NOTE: Water boils at around 212 °F and glycol does not boil until it reaches 549 °F. If the wet glycol is heated to an appropriate temperature, the water separates from the glycol in the form of vapor while the glycol remains a liquid.

- The water vapor is vented upward through a column on the top of the reboiler called the stripper.

The hotter the reboiler temperature, the more quickly the water can be removed. However, at approximately 400 °F, the glycol begins to break down and is no longer usable. For this reason production technicians should maintain the reboiler temperature (around 375-380 °F) as high as possible without risking glycol breakdown.

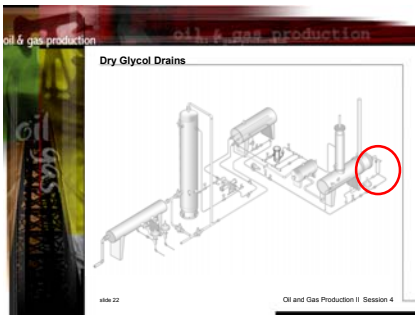
To further illustrate the importance of effective filtration:

Inside the reboiler, unfiltered contaminants build up on the fire tube forming a coating that insulates the tube and inhibits efficient heat transfer. In addition, this coating is uneven and results in hot spots on the tube. These hot spots can cause the fire tube to crack leading to expensive repairs.



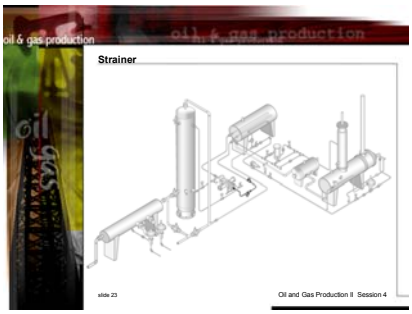
Show Slide 21:
Reboiler Stripper Column

- Inside the stripper, the rising vapor is stripped of any glycol content with the help of a coil called a reflux condenser.
- This process of removing any glycol from the vapor is called fractionation.
- The vapor, now almost pure water, is vented out the top.



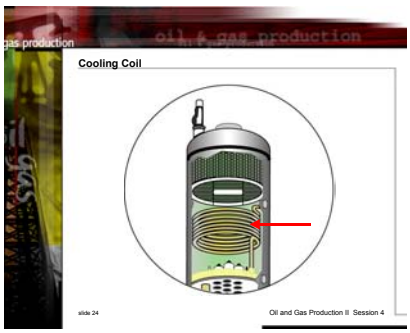
Show Slide 22:
Dry Glycol Drains

- The glycol, now dry, is drained from the bottom of the reboiler.



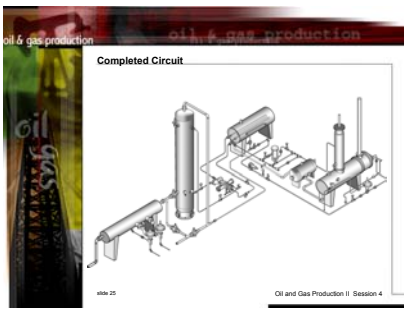
Show Slide 23
Strainer

- During the reboiling process, glycol picks up bits of scale and other particulates and must be subsequently pumped through a strainer before reentering the absorption tower.



Show Slide 24
Cooling Coil

- The glycol entering the top of the absorption tower is still hot from the reboiler.
- As the glycol begins to flow downward in the tower, the glycol passes through a cooling coil in the top of the absorption tower.
- Rising gas and mist cools the glycol before it begins to cascade down.

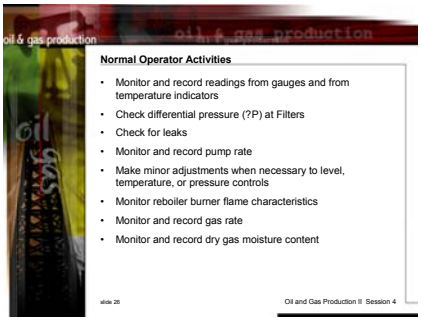


Show Slide 25
Completed Circuit

- This brings us back to the beginning of the dehydration circuit.

6. Normal Operations

Time: 10 minutes



Show Slide 26
Normal Operator Activities

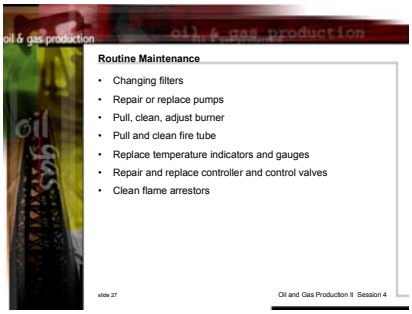
- Normal operator activities include:
  - Monitoring and recording readings from gauges and temperature indicators
  - Checking differential pressure (ΔP) at filters
  - Checking for leaks
  - Monitoring and recording pump rates
  - Making minor adjustments when necessary to level, temperature, or pressure controls
  - Monitoring reboiler burner flame characteristics *(see Tip)*
  - Monitoring and recording gas rate
  - Monitoring and recording dry gas moisture content *(see Tip)*

Burner flame characteristics indicate the quality of the gas being burned. A steady bluish flame with only a little yellow at the tip indicates good gas quality, while an unsteady reddish-yellow flame would indicate poor gas quality and/or an incorrect oxygen mix.

Recall that dry gas contracts set the upper limit of water suspended in the purchased gas of 7 lbs. per million cubic feet. In actual practice, dehydration operators may attempt to maintain a range of 4-6 lbs per million cubic feet. This limits the risk of contract violation while avoiding the expense of excessive dehydration.

7. Routine Maintenance

Time: 10 minutes



Show Slide 27
Routine Maintenance

- Routine dehydration system maintenance includes:
  - Changing filters
  - Repairing or replacing pumps
  - Pulling, cleaning and adjusting burner
  - Pulling and cleaning fire tube
  - Replacing temperature indicators and gauges
  - Repairing and/or replacing controller and control valves
  - Cleaning flame arrestors

The frequency with which maintenance activities are required depends on two factors.

1. The characteristics of the gas being treated
2. The careful and effective operation of the unit

8. Malfunctions and Troubleshooting

Time: 10 minutes

- Causes, symptoms and possible corrective action should be considered while troubleshooting dehydration unit problems.

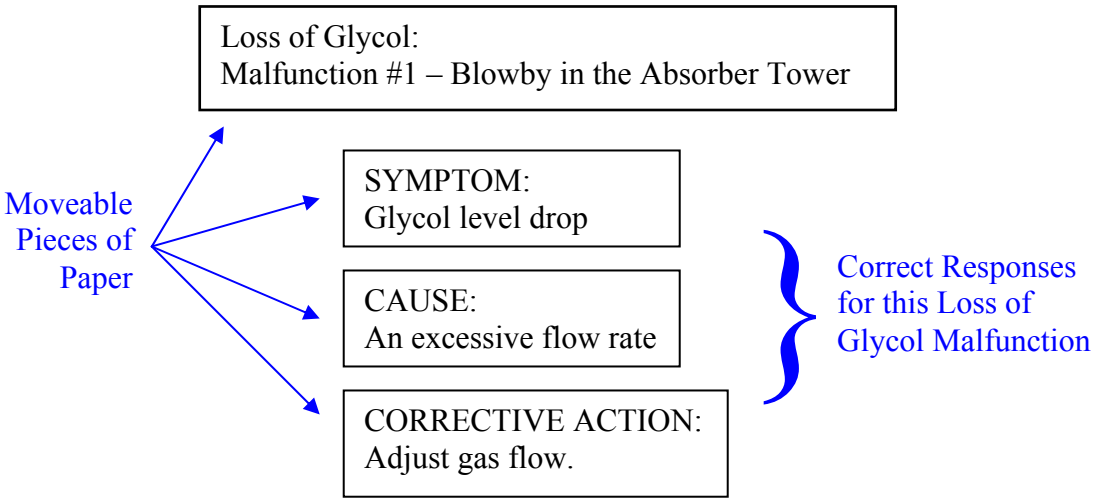
  Loss of Glycol

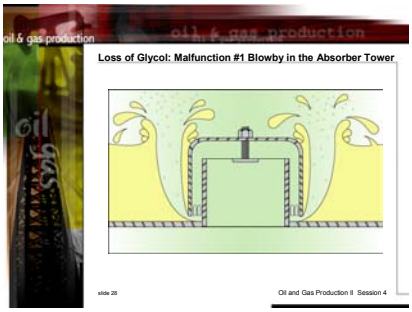
  - Glycol may become depleted from the system for more than one reason.

OPTIONAL ACTIVITY:

If instructor desires, the troubleshooting information (ALL of the Symptoms, Causes, Immediate Responses, and Corrective Actions) for Loss of Glycol and its four possible malfunctions may be printed out using large fonts on separate pieces of paper for each item. Have students make *educated* guesses as to where they belong. Let them select all that apply to all four types of malfunctions before giving corrective feedback on their selections. Slides may be backed up to do this.

EXAMPLE: Show slide #28 (Loss of Glycol – Malfunction #1: Blowby in the Absorber Tower), and then allow students to pick from all of the sheets the ones that pertain to the specific Loss of Glycol malfunction. Repeat through Slide 31. Then make feedback corrections as necessary.





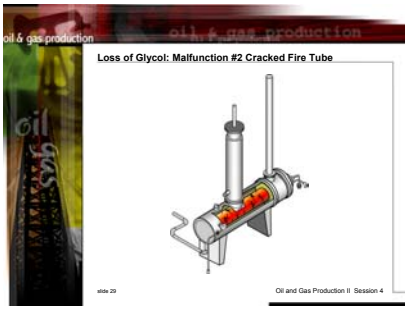
Show Slide 28
Loss of Glycol: Malfunction #1 Blowby in the Absorber Tower

Malfunction #1: Blowby in the Absorber Tower

- Symptom: Glycol level drop
- Cause: An excessive gas flow rate

NOTE: A normal flow rate results in the wet gas bubbling up through the glycol. At an excessive rate, the gas surges up through the glycol carrying glycol mist out with the gas.

– Corrective Action: Adjust gas flow



Show Slide 29
Loss of Glycol: Malfunction #2 Cracked Fire Tube

Malfunction #2: Cracked Fire Tubes

– Symptom: Glycol level drops and dirty exhaust billows from the reboiler.

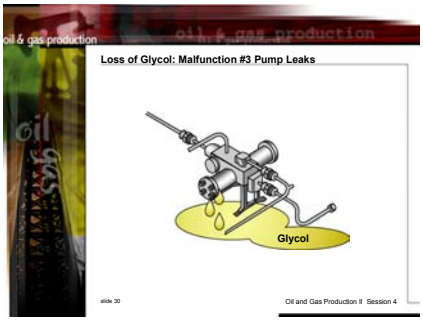
NOTE: A significant leak can lead to a spectacular fire since the burner stack usually provides good natural draft even after the operator has shut down the skid and turned off the fuel gas.

– Cause: Cracks in the fire tube can allow glycol to leak in and to ignite.

NOTE: Foaming may result in fire tube cracking that also allows glycol seepage and combustion in the fire tube.

– Immediate Response: A common method to extinguish fire tube/stack fires is to dump nitrogen (gas snuffing) from stored cylinders (bottles) into the firebox via special nitrogen inlet connections.

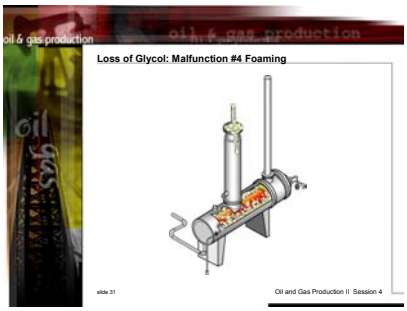
– Corrective Action: Repair and or replace fire tube.



Show Slide 30
Loss of Glycol: Malfunction #3 Pump Leaks

Malfunction #3: Pump Leaks

- Symptom: Glycol level drops and glycol is visible on the ground under pump
- Cause: Bad pump seal(s) allows glycol leakage
- Corrective Action: Repair and or replace pump seals



Show Slide 31
Loss of Glycol: Malfunction #4 Foaming

Possible Cause C: Pump Leaks

- Symptom: Glycol level drop
- Cause: Foaming takes place due to hydrocarbon impurities in the glycol. When foaming takes place in the reboiler, glycol is carried out through the stripper along with the water vapor.
- Corrective Action: Turn off burner flame and continue to circulate the glycol through the dehydration system.

  NOTE: The gas/glycol/condensate separator should remove the hydrocarbons. If the problem continues, verify that the condensate separator is functioning properly. A de-foaming agent may also used to correct this problem.

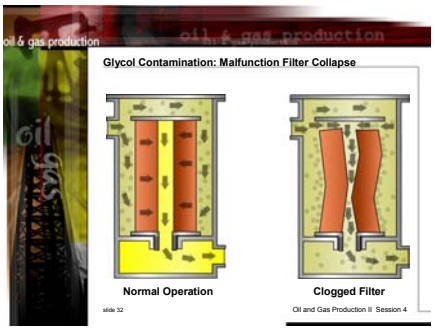
Break 10 minutes

9. Malfunctions and Troubleshooting *(continued)*

Time: 20 minutes

Glycol Contamination

- As previously mentioned, glycol contaminated with hydrocarbon lowers system efficiency and can result in dangerous conditions.



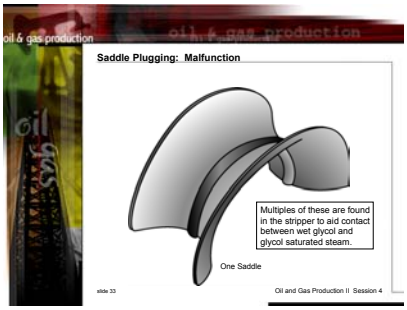
Show Slide 32
Glycol Contamination: Malfunction Filter Collapse

Malfunction: Filter Collapse

- Symptom: Glycol color changes from a light yellow-brown to a darker shade.
- Cause: A filter can become so clogged that flow pressure collapses the filter and allows the glycol to flow unfiltered.
- Immediate Corrective Action: Replace filter
- Follow up: Identify cause of collapse (e.g., Was the filter changed on time? What might have changed on the skid to cause the additional load on the filter?)

Saddle Plugging

- If the saddles inside the reboiler still column become clogged, the glycol backs up into the incoming glycol components.



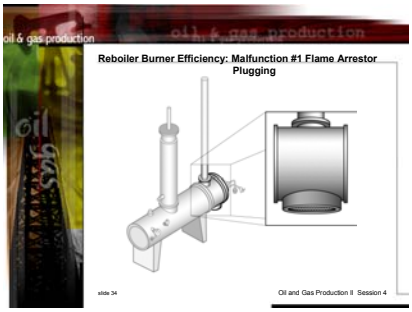
Show Slide 33
Saddle Plugging: Malfunction

Malfunction: Saddle Plugging

- Symptom: Reboiler pressure increases and the glycol level increases in the gas/glycol/condensate separator or surge tank
- Cause: Saddles clogged with contaminants
- Corrective Action: Replace column saddles.

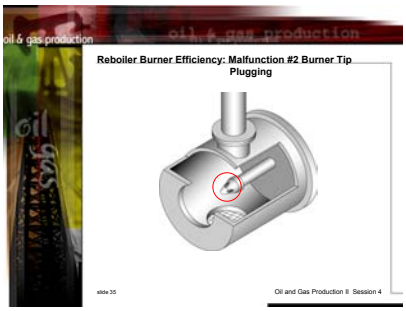
Poor Reboiler Burner Efficiency

- If the reboiler burner decreases in efficiency (uses more fuel to get desired heating results), the flame arrestor becomes plugged.



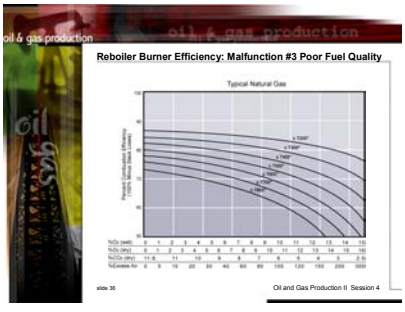
Show Slide 34
Reboiler Burner Efficiency: Malfunction #1 Flame Arrestor Plugging

- Symptoms:
  - Flame appearance (see Tip below)
  - Unable to maintain adequate temperature
- Corrective Action: Clean or replace flame arrestor



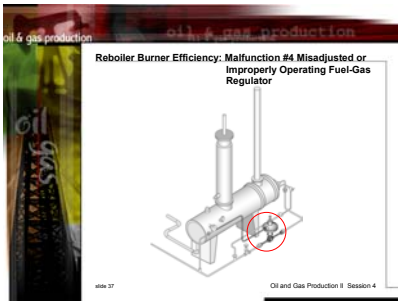
Show Slide 35
Reboiler Burner Efficiency: Malfunction #2 Burner Tip Plugging

- Corrective Action: Clean tips



Show Slide 36
Reboiler Burner Efficiency: Malfunction #3 Poor Fuel Quality

– Corrective Action: Check fuel-gas system



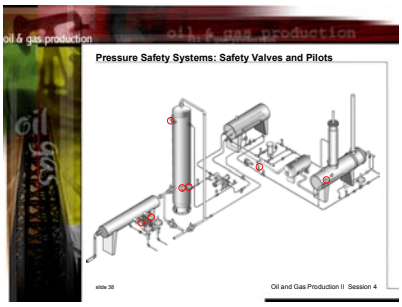
Show Slide 37
Reboiler Burner Efficiency: Malfunction #4 Misadjusted or Malfunctioning Fuel-Gas Regulator

– Corrective Action: Adjust, repair or replace regulator

10. Safety Systems

Time: 10 minutes

- The safety systems and equipment used in gas dehydration are described as follows:



Show Slide 38
Pressure Safety Systems: Safety Valves and Pilots

Level Safety Controls

– Location: Absorber, gas/glycol/condensate separator/reboiler

– Function: Actuate alarm and/or shut down

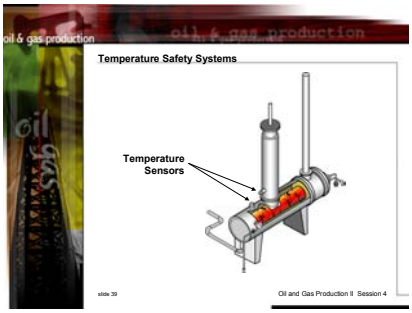
Pressure Safety Valves

– Location: On gas/glycol/condensate separator, on absorber tower

– Function: Releases excessive pressure to prevent catastrophic failure system components.

Pressure Safety Pilots

- Location: On gas/glycol/condensate separator, on absorber tower
- Function: Actuates alarm and/or shutdown



Show Slide 39
Temperature Safety Systems

Temperature Safety High (TSH) Switch

- Location: Reboiler still column and burner
- Function: Actuates alarm and/or burner shutdown.

Flame Arrestor

- Location: At mouth of reboiler fire tube
- Function: Confine flame within fire tube.

11. Safety, Health and Environmental Concerns

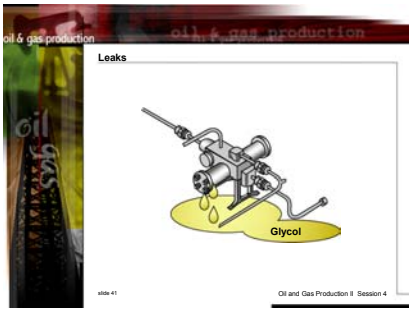
Time: 10 minutes

Show Slide 40
Toxic Gases: Benzene and H_2S

- As previously discussed, natural gas is not a single element but a mixture of hydrocarbon gases and impurities.

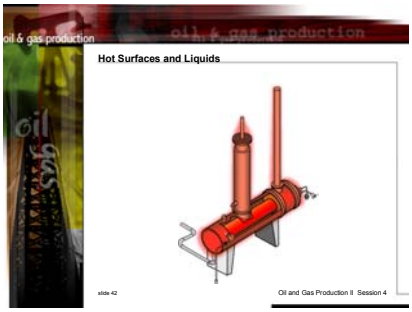
NOTE: Some of these gases and impurities are highly toxic. Benzene and H_2S are two examples. These may become concentrated in the glycol during dehydration. See website: http://www.sepac.ca/Newsletter/March%201996.pdf for additional information.

- Health and Safety Concern: Inhalation or skin contact while changing filters or while disposing of used glycol
- Recommended Precaution: Use proper PPE
- Environmental Concern: Toxic contamination of air or water table
- Recommended Precautions: Regular and frequent inspections. When necessary, adjust, repair or replace dehydration components.
- Follow approved disposal procedures.



Show Slide 41
Leaks

- Health And Safety Concerns: Slips and falls, skin exposure or inhalation
- Recommended Precaution: Use proper PPE
- Environmental Concern: Contamination of air or water table
- Recommended Precaution: Regular and frequent inspections, contain and properly dispose of all spills



Show Slide 42
Hot Surfaces and Liquids

- Health And Safety Concern: Possible burns from contact with reboiler components or from contact with lean glycol leaving reboiler
- Recommended Precaution: Proper PPE, heat insulation and barriers, post warning signs

12. Summary and Wrap-Up

Time: 10 minutes

1. Use learning objectives to summarize material presented during this session.
2. Encourage questions over any concepts that students do not understand.
3. **Remind students of the Test given at the beginning of class #5 that covers information from Session 1 through 4.**
4. Assign reading: Read appropriate text pages on gas compression to be presented during the next session.
5. Assign homework: Ask students to find an engineering company that specializes in Gas Dehydration projects and to perform an interview with one or more engineers from the particular company. Students may use the prepared questionnaire located in the Appendix. A report should be put together for presentation in the next session when they may be given the opportunity to discuss their findings.

   NOTE: Instructor should have a prepared list of acceptable engineering companies that have agreed to support this effort.

Break 10 minutes

13. Additional or Lab Activities

Time: 50 minutes

- Have students (individually or in small groups) compare and contrast the major differences in dehydration systems between onshore and offshore facilities, as well as between various regions within the United States as well as overseas.

  OPTION: Instructor may have a guest engineer (qualifications: has worked on several Gas Dehydration projects or has selected equipment for dehydration installations onshore and offshore) to come into the class and be interviewed by the students. The questions given in the Appendix for the homework assignment may be used to stimulate discussion.

- The individual/group representative may then report back to the group as to their findings.

- The following websites are resources for this information:
  - http://www.qatargas.com/corporate-profile/onshore.htm
  - http://www.typ.com.au/ipox/?bu=oil&su=ogppft
  - http://www.ptpcoalition.org/MemberWebsites/El%20Paso%20Energy%20Partners.htm
  - http://www.sheddenuhde.com.au/projects/ppt/BassGas.pdf
  - http://www.oilworks.com/October/feature8.html

    NOTE: CAPT is NOT responsible for the upkeep of any listed website; therefore, it is the responsibility of the Instructor to ensure these are current and operating prior to class. Also, in the event that computer workstations with internet capability are NOT available, downloads of these websites may be made for "one use in classroom" and are NOT intended for use as general distribution.