DECANTER SYSTEMS TROUBLESHOOTING MODULE
INSTRUCTOR LESSON PLAN

Overview

Decanting is used to separate mixtures of two immiscible liquids, two solids, or an insoluble solid and a liquid, where the components do not react chemically. It is one of the simplest means of separating mixtures, based on differences in the physical properties of components in a mixture, such as particle size or density.

Competency	Performance Standards
Troubleshoot problems with decanter systems	Performance will be satisfactory when: ☐ Learner recognizes the problem and captures the problem in written form. ☐ Learner evaluates HSE risks involved with continued operation. ☐ Learner recognizes when the HSE hazard/s warrants shutting down equipment. ☐ Learner collects and analyzes data associated with the problem. ☐ Learner rewords problem based on initial observations and reasoning. ☐ Learner identifies possible causes of the problem. ☐ Learner selects most probable cause of the problem, one that explains every observation. ☐ Learner proposes corrective action that is rational and eliminates true cause (when possible). ☐ Learner accurately and completely documents problem and corrective action(s). ☐ Process equipment is stabilized (if simulator-based problem). ☐ System is returned to within $\pm$ 5% of design parameters (if simulator-based problem).
	Conditions: Given a paper-based (P&ID) and/or simulator-based problem, competence will be demonstrated by the completion of troubleshooting steps and subsequent documentation.

Learning Objectives

1. Recall the purpose and types of decanter systems.
2. Recall potential problems associated with decanter systems.
3. Describe immediate actions a process technician could take to solve decanter system problems.
4. Explain the relationship between variables for a specific process under normal operating conditions.
5. Given normal and abnormal operating conditions for a specific process:
    - Recognize the problem.
    - Collect and analyze data associated with the problem.
    - Define the problem.
    - Identify possible causes and the most probable cause of the problem.
    - Evaluate the effect of investigative, compensating and corrective actions.
    - Select an appropriate corrective action.
    - Document the problem and corrective action.

Learning Activities

Time Frame	Learning Activity	Teaching Activity	Instructional Materials	Supplies and Equipment	Notes
	PREVIEW learning objectives and performance standards for this competency.		Learning Plan		
	READ information provided in the Introduction section.		Learning Plan		
	LISTEN to the lecture on the purpose and applications of decanter systems and associated problems (if provided).	Deliver a brief presentation on decanter systems and associated problems.		Lecture Equipment	Address first two learning objectives.
	REVIEW the process flow, product specifications, equipment specifications, normal operating conditions, and normal design conditions sections for the specified process.	Choose a specific problem/s for learners to solve. Lead discussion of process to assure learners understand all aspects.	Process Description		
	COMPLETE the Self-Check Questions worksheet.	Introduce activity. Review worksheet with learners after completion.	Self-Check Questions worksheet		Reinforce learning objectives 1, 2, and 4.
	BRAINSTORM immediate actions a process technician could take to solve decanter system problems with a small group of your peers.	Divide learners into groups of 3 to 4. Introduce activity.			
	COMPARE your list of immediate actions for solving decanter system problems to another group's work.	Write all actions on board or flipchart.			
	LISTEN to instructor expand on actions a process technician could take to solve decanter system problems.	Lecture on actions not captured and expand on those listed.		Lecture Equipment	Address the third learning objective.

	SOLVE at least one paper-based decanter system problem including the completion of the Abnormal Operating Conditions table and Troubleshooting Form.	Choose a specific problem/s for learners to solve. Guide learners as needed during the activity. Do a quick de-brief after activity.	Problem Packet		Information for three Scenarios has been provided for students. Address learning objective 5.
	OBSERVE a normal and/or abnormal condition on the simulator associated with a decanter system (if simulator is available).	Set up simulation. Guide learners as needed during the activity.		Simulator	
	SOLVE at least one simulator-based decanter system problem including the completion of the Troubleshooting Form (if simulator is available).	Create a problem/s for learners to solve. Program fault for simulator-based problem. Guide learners as needed during the activity. Do a quick de-brief after activity.	Troubleshooting Form	Simulator	Address learning objective 5.

DECANTER SYSTEMS TROUBLESHOOTING MODULE
PROCESS DESCRIPTION

Process Overview

Decanting is used to separate mixtures of two immiscible liquids, two solids, or an insoluble solid and a liquid, where the components do not react chemically. It is one of the simplest means of separating mixtures, based on differences in the physical properties of components in a mixture, such as particle size or density. The more different these properties are, the easier it is to separate them. Residence time is also an important factor in the process, as the material needs a sufficient amount of time for the separation to occur. While decanting is a very effective means of separating materials in a mixture, it does not yield 100% separation and a small amount of each of the mixture components will remain in the discharge of the other.

Some examples of where the decanting process is used are:

- To separate cream from milk, where the milk is denser than the cream, which rises to the top.
- In the panning of gold, where the gold particles are heavier than the accompanying particles of sand, mud, and gravel.
- To purify muddy water, where the dirt particles will settle to the bottom and leave clear water.
- In the separation of water from a hydrocarbon, such as kerosene, where the less dense hydrocarbon rests on top of the water.

In refining, specific examples of where decanting is used include:

- Distillation column overhead reflux drums, where water in the column reflux stream can cause corrosion of the internal tower components to occur.
- Caustic treating units, where hydrocarbon entrained with solvent can cause foaming in the downstream tower, resulting in production issues.
- Alkylation units, where a failure to separate sulfuric acid or caustic from a hydrocarbon stream will result in increased acid/caustic usage and an increased risk for corrosion in downstream equipment.

Decantation Equipment

Equipment in a decanting system includes a decanting vessel and its associated internal parts, pumps, piping, valves, and instrumentation.

The design of a decanting vessel is dependent on the anticipated rate of flow of the two components in the feed stream, the characteristics of the material and the application the decanter will be used for. A decanting vessel may be vertically or horizontally constructed. While a horizontal vessel provides a greater interface area, a vertical vessel has a much smaller footprint. If the amount of the heavier component in the mixture is expected to be much less than that of the lighter material, the drum may contain a boot where the heavier component will accumulate. If the amount of the lighter material to be separated out of the mixture is significant, an overflow weir is used to separate the two components. In some instances, both a weir and a boot are used to ensure good separation of the material. In a vertical vessel, an overflow weir separates the vessel into two sections, where each of the components in the mixture will accumulate and be drawn from.

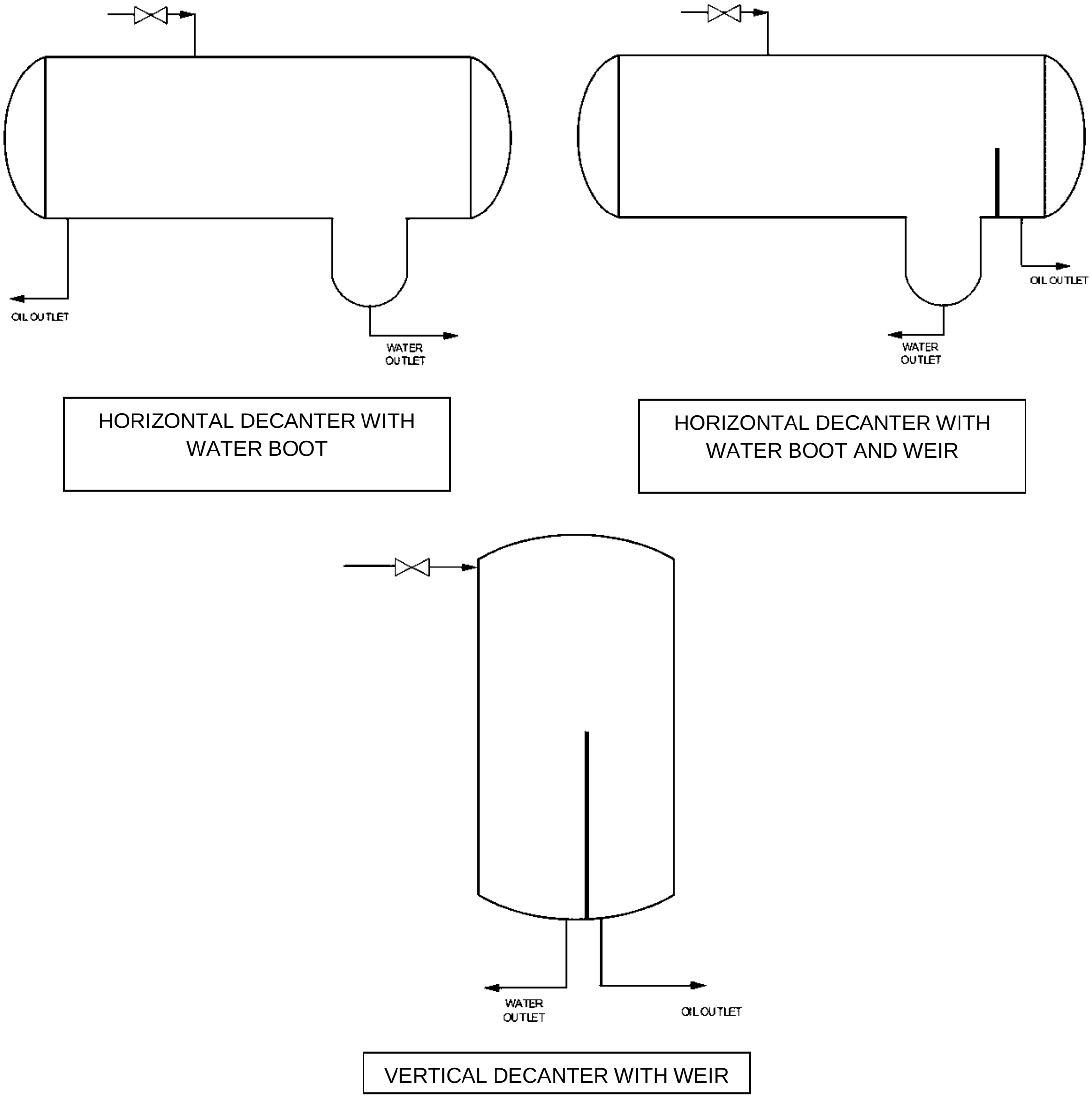

Figure 1. Decantation Equipment

A decanting system may also utilize pumps to remove the separated components from the decanting vessel and instrumentation to control flow and level. When the level instrument on the water side of the vessel is designed to measure the level of the interface, it is important that it is not allowed to reach the height of the top of the weir, to prevent water spill-over into the oil side of the vessel.

Process Description

In the following process, a mixture of hydrocarbon and water enters the decanting drum through piping that opens into the vessel, below the interface level, to minimize turbulence which would disturb the interface. The feed flow rate is metered by FI-09. Level instrument LIC-10 controls the level of the interface, the point at which the oil and water meet. Water settles to the bottom of the drum and is pumped out by P-1A/B. Water flow is metered by FI-10. The oil in the feed, with a specific gravity less than that of the water, will settle to the top of the water and overflow the weir and be pumped out of the vessel by P-2A/B. Oil level is controlled by level instrument LIC-11, while flow is metered by FI-11.

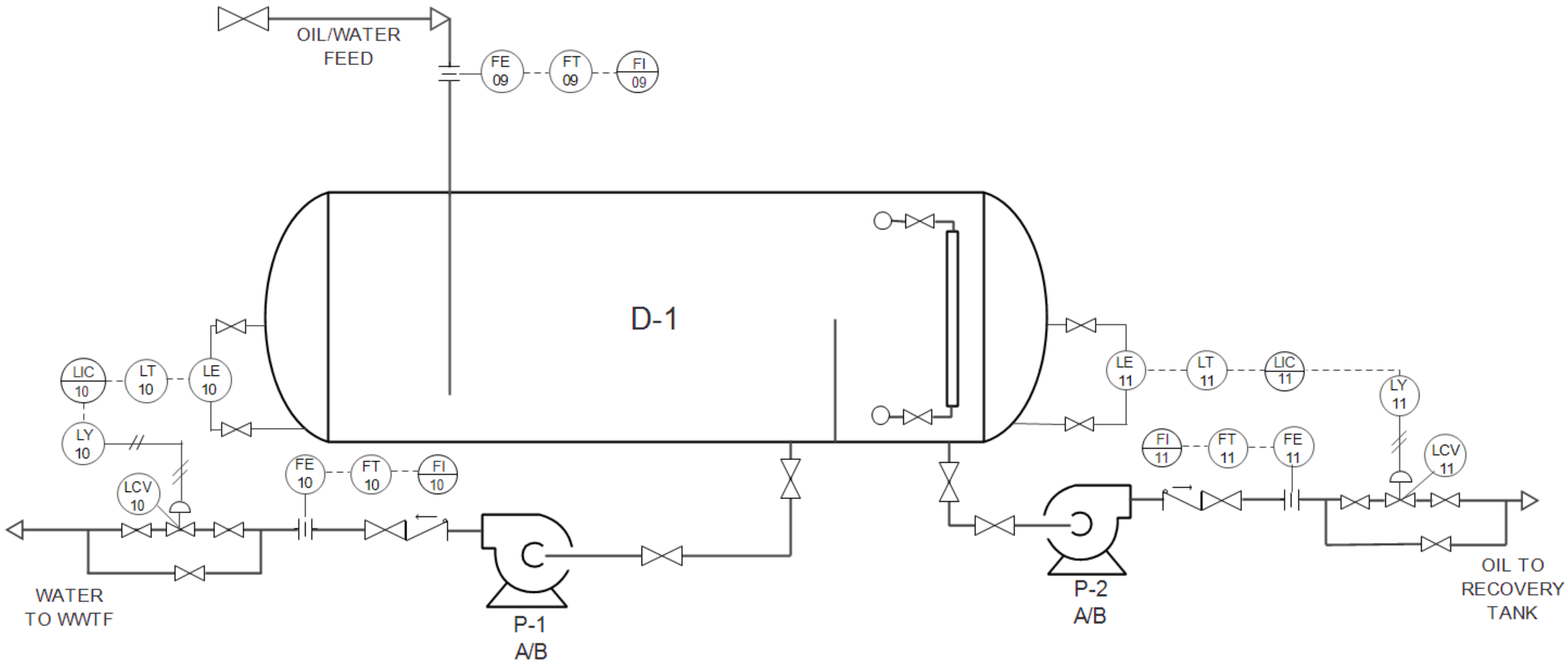

Figure 2. **Decanting Process**

Variables Affecting Decanter Operation

Variables that can have a significant impact on the operation of the decanter and the efficiency of the separation process include:

Feed Composition – Changes in feed composition can change the specific gravity of the mixture and affect the separation process, as well as the performance of the instruments, which are calibrated for the expected properties of the materials they measure. Changes in the viscosity of the feed will also affect the time required for separation to occur.

Feed Rate – A significant change in the feed rate impacts the separation time and can lead to water carry-over or oil carry-under

Residence Time – The time needed for the materials in the mixture to settle and separate is calculated based on the normal operating conditions. Changes in residence time affect the amount of separation and can lead to a widening of the interface

Feed Temperature – The optimal separation occurs in a specific temperature range. Changes in the temperature of the feed impact the ability of the components to settle out and can lead to an emulsification of the interface.

Equipment and Instrumentation

Table 1. Equipment List

D-1	Decanter Vessel	Vessel in which separation occurs
P-1A/B	Water Side Pumps	Pumps water from D-1 to the facility's wastewater treatment plant
P-2A/B	Oil Side Pumps	Pumps oil from D-1 to the oil recovery tank

Table 2. Instrumentation List

FI-09	Feed Inlet Flow Indicator	Normal feed rate is 34,000 BPD
FI-10	Water Outlet Flow Indicator	Normal flow rate is 22,000 BPD
LIC-10	Oil/Water Interface Level Controller	Normal level is 50%
FI-11	Oil Outlet Flow Indicator	Normal flow rate is 12,000 BPD
LIC-11	Oil Side Level Controller	Normal level is 50%

Normal Operating Conditions

Table 3. Normal Operating Conditions

Tag ID	Instrument Range	Normal Value	Instrument Indication	Eng. Units	Output %
FI-09	0-50,000	34,000	68%	BPD	---
FI-10	0-40,000	22,000	55%	BPD	---
LIC-10	0-100	50%	50%	%	50%
FI-11	0-30,000	12,000	40%	BPD	---
LIC-11	0-100	50%	50%	%	50%

DECANTER SYSTEMS TROUBLESHOOTING MODULE
SELF-CHECK QUESTIONS

1. What is the purpose of a decanter?

   A decanter is used to separate mixtures of two immiscible liquids, two solids, or an insoluble solid and a liquid, where the components do not react chemically.

2. Explain how a decanter operates.

   A mixture is separated by settling, which allows the components of the mixture to separate according to their specific gravities.

3. List three examples of where decanting is used, outside of the process industries.

   - *To separate milk from cream*
   - *Gold panning*
   - *Clarifying muddy water*
   - *Removing grape solids in the wine making process*
   - *Operation of a septic system*

4. When could a 'boot' design be used in a decanter?

   When the amount of the heavier component in the mixture is expected to be much less than that of the lighter material

5. Why does the feed inlet piping open into the vessel below the normal interface level?

   To minimize turbulence, which disturbs the interface

6. Name three variables that will affect the operation of a decanter and explain how they will affect it.

   <u>Feed Composition</u> – *Changes in feed composition can change the specific gravity of the mixture and affect the separation process, as well as the performance of the instruments, which are calibrated for the expected properties of the materials they measure. Changes in the viscosity of the feed will also affect the time required for separation to occur.*

   <u>Feed Rate</u> – *A significant change in the feed rate will impact the separation time and can lead to water carry-over or oil carry-under*

   <u>Residence Time</u> – *The time needed for the materials in the mixture to settle and separate is calculated based on the normal operating conditions. Changes in residence time will affect the amount of separation and can lead to a widening of the interface*

   <u>Feed Temperature</u> – *The optimal separation occurs in a specific temperature range. Changes in the temperature of the feed will impact the ability of the components to settle out and can lead to an emulsification of the interface*

7. Explain what water carry-over is, how it can occur, and the effect it has on plant operation.

   <u>What it is</u> – *Water carry-over is water that reaches the oil side of a decanter vessel.*

   <u>How it can occur</u> – *It occurs when the interface level is allowed to reach the top height of the weir and it spills into the oil compartment of the decanter vessel or when separation is not taking place in the first section of the decanter.*

Effect on plant operation – Water settles to the bottom of the oil compartment and is pumped out to the oil recovery tank, which can have a detrimental effect on downstream operations.

8. How would LIC-10 and LIC-11 react to a sudden increase in FI-09?
   - *LIC-10 would increase, causing LCV-10 to open to allow more water out.*
   - *LIC-11 would also increase, as long as feed composition didn't change.*
   - *LCV-11 would open to allow more oil to leave the decanter to maintain the level at the desired setpoint.*
9. What could cause a wide interface band to develop, and what effect would it have on decanter operation?

   Possible causes – change in feed composition, change in feed temperature, and a decrease in residence time

   Effect on decanter operation – a wide interface band, called emulsification, could result in water carry-over to the oil recovery tank or oil carry-under to the WWTF. Interface level instrument, LIC-10, may not read correctly
10. If P-1A was in the shop for repairs and P-1B failed, what impact would the pump failure have on the decanter?

    Water would not be pumped out of the decanter, resulting in the level (LIC-10) rising and material spilling over the weir into the oil side of the decanter.

    Both LIC-10 and LIC-11 would read 100% and all material in the drum would be pumped out by P-2A/B.

DECANTER SYSTEMS TROUBLESHOOTING MODULE
SCENARIO #1 (PAPER-BASED)

Scenario Statement

While making your unit rounds, you notice that P-2A appears to be cavitating intermittently.

Troubleshoot this problem and complete the Troubleshooting Form.

Abnormal Operating Conditions

Table 4. Abnormal Conditions

Tag ID	Instrument Range	Current Value	Instrument Indication	Output %
FI-09	0-50,000	34,000	68%	---
FI-10	0-40,000	22,000	55%	---
LIC-10	0-100	50%	50%	50%
FI-11	0-30,000	3,000-15,000	10% - 50%	---
LIC-11	0-100	50%	50%	50%

Observations

Checking the level instrument (LIC-11), will show that it seems to be holding at~50%. All instrumentation appears to be functioning as designed, except that the FI-11 reading is not steady, ranging from 3,000-15,000 BPD of flow.

Cause

Higher liquid density will cause the <u>measured</u> liquid level to be higher than the <u>actual</u> level.

A change in the feed composition, so that the oil in the feed is heavier and denser, can result in an incorrect level instrument reading on LIC-11 (reading high).

Some difference may be seen in the LIC-10 reported level vs. the actual level, but the difference in the interface level will not be large enough to result in oil carry-under, as long as there is sufficient residence time for adequate separation to occur.

Separation will become more difficult as the density of the hydrocarbon increases and moves closer to that of the water.

Investigative Actions

Checking the level in the gauge glass should show the actual level in the decanter to be lower than the LIC-11 instrument reading, and point students in the right direction, but won't determine the cause of the problem.

Compensating Actions

Moving the level setpoint will show that the controller is responding correctly.

When the setpoint is raised, the fluctuation in flow rate should stop, as well as the pump cavitation.

Corrective Actions

Re-calibrate instrument (LIC-11) using the new specific gravity.

If the condition is temporary, raise the setpoint of LIC-11 to compensate for the difference between the instrument reading and the actual level.

TROUBLESHOOTING FORM

1. **Recognize (and write) the problem.**

*(What **is** happening that should not be or what **is not** happening that should be?)*

P-2A is cavitating, causing FI-11 to be unsteady.

2. **Stabilize the system.**

(Does it need fixing? Stabilize the unit. Can we keep the unit running? Do we need to shut it down?)

If not corrected, pump cavitation can cause damage to the pump components such as the seal, impeller, bearings, etc.

3. **Collect and analyze the data.**

(Look for changes, differences, readings that have not changed, etc. Write down all observations. After every observation, write down the reason why. Then answer why for each reason.

Ex. Observation why? because Reasoning why? because Reasoning why? because Reasoning...)

Y N a. *FI-09 (feed into D-1) has not changed.*

why? because *there was no change in upstream operations.*

why? because

why? because

Y N b. *FI-10 (water flow out of D-1) has not changed.*

why? because *LIC-10 has not changed.*

why? because *FI-09 has not changed.*

why? because *there was no change in upstream operations.*

Y N c. *LIC-10 (D-1 water side interface level) has not changed.*

why? because *FI-09 has not changed.*

why? because *there was no change in upstream operations.*

why? because

Y N d. *FI-11 (oil flow out of D-1) is unsteady.*

why? because *there is a problem with P-2A.*

why? because *internal pump components are damaged.*

why? because *of wear, poor design, improper installation or maintenance, improper operation, or manufacturing issue*

Y N e. *FI-11 (oil flow out of D-1) is unsteady.*

why? because *LIC-11 is not reading correctly.*

why? because *of mechanical failure of the instrument*

why? because *of wear, poor design, improper installation or maintenance, improper operation, or manufacturing issue*

Y N f. *LIC-11 (D-1 oil side level) has not changed (but should have).*

why? because *FI-11 is unsteady.*

why? because *of instrument malfunction*

why? because *of feed composition, rather than volume change.*

Y N g.

why? because

why? because

why? because

Y N h. ______________________________

why? because______________________________

why? because______________________________

why? because______________________________

Y N i. ______________________________

why? because______________________________

why? because______________________________

why? because______________________________

Y N j. ______________________________

why? because______________________________

why? because______________________________

why? because______________________________

4. After initial observations and reasoning, **reword the problem** as specifically as possible.

Although incoming feed and both levels in D-1 appear to be steady, water flow out of D-1 is not.

5. List **possible causes** of the problem.

Y N *a. P-2A internal problem*

Y N a. *LIC-11 not functioning properly*

Y ***N*** b. *FI-11 not functioning properly*

Y N c. *Feed composition change*

Y N d. ______________________________

***Would each possible cause explain the problem? Circle **Y** or **N** beside each possible cause.

6. List the **most probable cause** of the problem. *(Use your knowledge, experience and best judgment.)*

LIC-11 not functioning properly

Feed composition change

*** Does this cause explain every observation? Circle **Y** or N beside every observation.

7. Determine alternative solutions and select solution.

a. What would be an **investigative** action you could take at this point? What would be the effect?

Check oil side level in gauge glass to confirm accuracy of LIC-11 reading, move setpoint on LIC-11 to observe controller response.

b. What would be a **compensating** action you could take at this point? What would be the effect?

Raise LIC-11 setpoint to raise actual level to a point which will maintain flow to P-2 and stop pump cavitation.

c. What would be a **corrective** action you could take at this point? What would be the effect?

Recalibrate LIC-11 using the new specific gravity of the product.

d. What will be the **effect** of the above actions? *(Would any of the actions cause other problems?)*

If new specific gravity range is temporary, LIC-11 will need to be recalibrated again.

____

8. Take the **corrective action** *(if empowered or within your responsibility).*

9. **Follow-up.** *(Was the problem eliminated? Was the "real" cause eliminated? What caused the real cause? You may need to start the problem-solving process again.)*

Problem was eliminated. Cause (change in feed composition) was not eliminated, but a change in decanter operation allowed the unit to return to normal conditions.

10. **Document and share** with others.
(Document problem and actions taken in logbook or report; communicate with others.)

DECANTER SYSTEMS TROUBLESHOOTING MODULE
SCENARIO #2 (PAPER-BASED)

Scenario Statement

Control panel shows a sudden loss of flow reading on FI-10 and a corresponding rise in LIC-10 to 100%.

Troubleshoot this problem and complete the Troubleshooting Form.

Abnormal Operating Conditions

Table 5. Abnormal Conditions

Tag ID	Instrument Range	Current Value	Instrument Indication	Output %
FI-09	0-50,000	34,000	68%	---
FI-10	0-40,000	0	0%	---
LIC-10	0-100	100%	100%	100%
FI-11	0-30,000	29,000	100%	---
LIC-11	0-100	100%	100%	100%

Observations

Instruments indicate that there is no flow from the water side of the decanter.

Instrumentation appears to be working correctly…LCV-10 is wide open in response to 100% reading on LIC-10, although FI-10 shows zero flow.

LCV-11 has opened wide in response to LIC-11 rising to 100%. FI-11 reflects the 100% opening of LIC-11.

Flow out of the decanter is 5,000 BPD less than the amount of feed into the decanter, so level will continue to rise if no corrective action is taken.

Cause

Field check the equipment to determine the exact cause of the problem, but possibilities include loss of P-1, problem with LCV-10 (failed closed), dropped gate, line pluggage, or downstream block valve being closed.

Investigative Actions

Verify high decanter level in gauge glass.

Check status of the in-service P-1, and swing pumps, putting the stand-by P-1 in service to rule out pump problem.

Open bypass around LCV-10 to determine if valve is the cause of the problem.

Verify valve line-up between D-1 and WWTF

Conduct pressure survey of line to determine if line pluggage or dropped gate exists somewhere in the system.

Compensating Actions

Putting a second P-2 in service will increase pumping capacity to prevent the decanter level from going over the top and backing into the feed line, but oil/water separation will not be achieved.

Cutting the feed rate may also help in controlling drum level.

Corrective Actions

If the in-service P-1 is found to be off, restart pump. If pump won't restart, put stand-by P-1 in service. If putting on the stand-by pump resolves the issue, repair the initial in-service P-1.

If opening the LCV-10 bypass resolves the issue, have instrumentation technician determine which component of the instrument has failed and make necessary repairs.

If line pluggage or dropped gate is the cause of the problem, pressure survey should indicate where in the line the problem exists. If plugged, flush the line to clear—if flushing that section of piping is not possible or unsuccessful, or if a dropped gate is indicated, decanter must be taken out of service.

TROUBLESHOOTING FORM

1. **Recognize (and write) the problem.**
   *(What **is** happening that should not be or what **is not** happening that should be?)*
   FI-10 went to zero.

2. **Stabilize the system.**
   (Does it need fixing? Stabilize the unit. Can we keep the unit running? Do we need to shut it down?)
   If not resolved, water will flow over the weir and mix with oil leaving D-1. No separation will occur.

3. **Collect and analyze the data.**
   (Look for changes, differences, readings that have not changed, etc. Write down all observations. After every observation, write down the reason why. Then answer why for each reason.
   Ex. Observation why? because Reasoning why? because Reasoning why? because Reasoning...)

Y N a. *FI-09 has not changed.*
why? because *there was no change in upstream operations.*
why? because
why? because

Y N b. *FI-10 decreased from 22,000 to 0 (zero) BPD.*
why? because *LCV-10 closed.*
why? because *regulator air line broke.*
why? because *of vibration, poor design, improper installation or maintenance, improper operation, or manufacturing issue*

Y N c. *FI-10 decreased from 22,000 to 0 (zero) BPD.*
why? because *P-1 shut down.*
why? because *switch was shut off.*
why? because *of operator/maintenance worker error*

Y N d. *FI-10 decreased from 22,000 to 0 (zero) BPD.*
why? because *P-1 shut down*
why? because *there is a mechanical or electrical problem with P-1.*
why? because *of wear, poor design, improper installation or maintenance, improper operation, or manufacturing issue*

Y N e. *FI-10 decreased from 22,000 to 0 (zero) BPD.*
why? because *a valve is shut in the water outlet line between D-1 and the WWTF.*
why? because *of operator error*
why? because *of lack of communication, misunderstanding, or lack of knowledge about proper line-up*

Y N f. *FI-10 decreased from 22,000 to 0 (zero) BPD.*
why? because *there is pluggage in the line.*
why? because *particulate matter in the feed has accumulated in the D-1 water outlet line.*
why? because *of poor design, improper installation, maintenance, or operation*

Y N g. *FI-10 decreased from 22,000 to 0 (zero) BPD.*
why? because *there is a valve with a dropped gate in the water line between D-1 and the WWTF.*
why? because *of wear, poor design, improper installation or maintenance, improper operation, or manufacturing issue*
why? because

_Y_ N *h.* *FI-11 has increased from 12,000 to 29,000 BPD.*

why? because *LCV-11 is wide open.*

why? because *LIC-11 has increased from 50% to 100%.*

why? because *LIC-10 has increased from 50% to 100%.*

_Y_ N *i.* *FI-11 has increased from 12,000 to 29,000 BPD.*

why? because *LIC-10 has increased from 50% to 100%.*

why? because *FI-10 has decreased from 22,000 to 0 BPD.*

why? because

4. After initial observations and reasoning, **reword the problem** as specifically as possible.

FI-10 (water out of D-1) has gone to zero and LIC-10 has increased to 100%. Spillover is occurring, causing LIC-11 to increase to 100% and FI-11 to increase to its max. value.

5. List **possible causes** of the problem.

_Y_ N *a.* *Loss of P-1*

_Y_ N *b.* *Failure of LIC-10/LCV-10*

_Y_ N *c.* *Dropped gate in D-1 water outlet line*

_Y_ N *d.* *Valve shut on line between D-1 and WWTF*

_Y_ N *e.* *Pluggage in D-1 water outlet line (but usually recognized before total line pluggage occurs)*

*****Would each possible cause explain the problem? Circle **Y** or **N** beside each possible cause.

6. List the **most probable cause** of the problem. *(Use your knowledge, experience and best judgment.)*

Loss of P-1

Failure of LIC-10/LCV-10

Dropped gate in D-1 water outlet line

***** Does this cause explain every observation? Circle **Y** or N beside every observation.

7. Determine alternative solutions and select solution.

a. What would be an **investigative** action you could take at this point? What would be the effect?

Field check P-1 operation, verify that LCV-10 is wide open, verify line-up, and conduct pressure survey of D-1 water outlet line.

b. What would be a **compensating** action you could take at this point? What would be the effect?

Put stand-by P-1 in service to restore flow, open bypass around LCV-10 to rule out problem with it,

c. What would be a **corrective** action you could take at this point? What would be the effect?

Repair P-1 to restore back-up capability, repair problem with LCV-10, correct line-up, and flush line to clear pluggage.

d. What will be the **effect** of the above actions? *(Would any of the actions cause other problems?)*

Restore normal operation of decanter.

8. Take the **corrective action** *(if empowered or within your responsibility).*

9. **Follow-up.** *(Was the problem eliminated? Was the "real" cause eliminated? What caused the real cause? You may need to start the problem-solving process again.)*

Yes, the problem will be eliminated after cause is identified and corrected.

10. **Document and share** with others.
(Document problem and actions taken in logbook or report; communicate with others.)

DECANTER SYSTEMS TROUBLESHOOTING MODULE
SCENARIO #3 DESCRIPTION

Scenario Statement

While unit operations are steady, you notice that LIC-11 valve is opening to control the oil level in the vessel.

Troubleshoot this problem and complete the Troubleshooting Form.

Abnormal Operating Conditions

Table 6. Abnormal Conditions

Tag ID	Instrument Range	Current Value	Instrument Indication	Output %
FI-09	0-50,000	34,000	68%	
FI-10	0-40,000	16.000	40%	
LIC-10	0-100	50%	50%	35%
FI-11	0-30,000	18,000	60%	
LIC-11	0-100	50%	50%	65%

Observations

LIC-10 is maintaining a normal level of 50%, although LCV-10 has decreased from 50% to 35%.

LIC-11 is maintaining a normal level of 50%, although LCV-11 has increased from 50% to 65%.

Flow through D-1 is in material balance (FI-09 = FI10 + FI11).

FI-10 has decreased by the same amount that FI-11 has increased.

Cause

If feed sample results show no change in composition, then some of the water is getting past the weir in the vessel, mixing and exiting with the oil.

Investigative Actions

Although feed rate is unchanged, pull a sample to have composition analyzed.

Sample oil side outlet at P-2 for water content.

Verify LIC-10 and LIC-11 accuracy.

Check oil side gauge glass to determine contents of oil side of vessel.

Compensating Actions

Swing oil side product to an off-spec tank, reduce feed rate to reduce amount of off-specification product produced.

Corrective Actions

Decanter will have to be taken out of service to allow for entry into the drum and repair of weir.

TROUBLESHOOTING FORM

1. **Recognize (and write) the problem.**
   *(What **is** happening that should not be or what **is not** happening that should be?)*
   With no change in feed rate, LIC-11 is opening to maintain oil level in D-1.

2. **Stabilize the system.**
   (Does it need fixing? Stabilize the unit. Can we keep the unit running? Do we need to shut it down?)
   System appears to be stable, although LIC-11 has opened, and LIC-10 has cut back.

3. **Collect and analyze the data.**
   (Look for changes, differences, readings that have not changed, etc. Write down all observations. After every observation, write down the reason why. Then answer why for each reason.
   Ex. Observation why? because Reasoning why? because Reasoning why? because Reasoning...)

Y N a. *FI-09 has not changed.*

why? because *there was no change in upstream operations.*

why? because

why? because

Y N b. *FI-10 is down to 16,000 from 22,000 BPD.*

why? because *LIC-10 is lower.*

why? because *there is less water in D-1 feed.*

why? because *there was a change in feed composition.*

Y N c. *FI-10 is down to 16,000 from 22,000 BPD.*

why? because *LIC-10 is lower.*

why? because *there is less material in the water side of D-1.*

why? because *some water is getting into the oil side of D-1.*

Y N d. *LIC-10 output is down to 35% from 50%.*

why? because *there is less water in the feed into D-1.*

why? because *feed composition has changed.*

Y N e. *FI-11 has increased from 12,000 to 18,000 BPD.*

why? because *LIC-11 output has increased from 50% to 65%.*

why? because *there is more material on the oil side of D-1.*

why? because *the feed composition into D-1 has changed.*

Y N f. *FI-11 has increased from 12,000 to 18,000 BPD.*

why? because *LIC-11 output has increased from 50 % to 65%.*

why? because *there is more material on the oil side of D-1.*

why? because *there is a hole in the weir.*

Y N g. *LIC-11 output is up to 65% from 50%.*

why? because *there is more material on the oil side of D-1.*

why? because *feed composition has changed or there is a hole in the D-1 weir.*

why? because *of wear, poor design, improper installation or maintenance, improper operation, or manufacturing issue*

Y N h. ______

why? because ______

why? because ______

why? because ______

Y N i. ______

why? because ______

why? because ______

why? because ______

Y N j. ______

why? because ______

why? because ______

why? because ______

4. After initial observations and reasoning, **reword the problem** as specifically as possible.

Although the D-1 feed rate has not changed, there appears to be less material on the water side and more material on the oil side of D-1.

5. List **possible causes** of the problem.

Y N *a. Change in feed composition*

Y N *b. Hole in weir*

Y ***N*** *c. FI-09 reading incorrectly (low)*

Y ***N*** *d. LIC-10 reading incorrectly*

Y N e. ______

*****Would each possible cause explain the problem? Circle **Y** or **N** beside each possible cause.

6. List the **most probable cause(s)** of the problem. *(Use your knowledge, experience and best judgment.)*

Change in feed composition

Hole in weir

***** Does this cause explain every observation? Circle **Y** or N beside every observation.

7. Determine alternative solutions and select solution.

a. What would be an **investigative** action you could take at this point? What would be the effect?

Sample feed and oil side outlet for lab analysis (for composition).

b. What would be a **compensating** action you could take at this point? What would be the effect?

Reduce feed rate to minimize amount of off-spec product produced.

c. What would be a **corrective** action you could take at this point? What would be the effect?

Take D-1 out of service to repair hole in weir. Notify upstream unit of the change in feed composition.

d. What will be the **effect** of the above actions? *(Would any of the actions cause other problems?)*

With decanter out of service, there are no means of separating oil and water from feed stream.

8. Take the **corrective action** *(if empowered or within your responsibility).*

9. **Follow-up.** *(Was the problem eliminated? Was the "real" cause eliminated? What caused the real cause? You may need to start the problem-solving process again.)*

   Yes, once D-1 is taken out of service and hole in weir is repaired, problem will be eliminated.

   If sample results indicate feed composition change, notify the upstream unit.

10. **Document and share** with others.
    (Document problem and actions taken in logbook or report; communicate with others.)

PERFORMANCE ASSESSMENT ACTIVITY #1
PAPER-BASED PROBLEM

Learner Directions: In this assessment, you will analyze and solve a paper-based decanter system problem. Your instructor will provide you with the problem scenario and supporting materials. Complete and submit all documentation requested including an Abnormal Operating Conditions table and Troubleshooting Form to your instructor.

Competency: Troubleshoot problems with a decanter system.

Performance Criteria: Performance will be satisfactory when:

- Learner recognizes the problem and captures the problem in written form.
- Learner evaluates HSE risks involved with continued operation.
- Learner recognizes when the HSE hazard/s warrants shutting down equipment.
- Learner collects and analyzes data associated with the problem.
- Learner rewords problem based on initial observations and reasoning.
- Learner identifies possible causes of the problem.
- Learner selects most probable cause of the problem, one that explains every observation.
- Learner proposes corrective action that is rational and eliminates true cause (when possible).
- Learner accurately and completely documents problem and corrective action/s.

Conditions: Given a paper-based problem (which may include a process description, equipment specifications, normal and abnormal operating conditions and appropriate tools), competence will be demonstrated by the completion of troubleshooting steps and subsequent documentation.

Assessment Strategy: Skill-based Performance Test

Standard: To be determined by the instructor. Example: Satisfactory performance requires learner must meet all criteria on the checklist.

DECANTER SYSTEMS TROUBLESHOOTING RUBRIC
PAPER-BASED PROBLEM

Competency: Troubleshoot problems with a decanter system.

CRITERIA	SCALE			
Product				
1. Documentation is accurate.	4	3	2	1
2. Documentation is complete.	4	3	2	1
3. Documentation reflects correct use of terminology.	4	3	2	1
Process				
1. Learner recognizes the problem and captures the problem in written form.	4	3	2	1
2. Learner evaluates and documents HSE risks involved with continued operation.	4	3	2	1
3. Learner recognizes and documents when the HSE hazard/s warrants shutting down equipment.	4	3	2	1
4. Learner collects and analyzes data associated with the problem.	4	3	2	1
5. Learner rewords problem based on initial observations and reasoning.	4	3	2	1
6. Learner identifies possible causes of the problem.	4	3	2	1
7. Learner selects most probable cause of the problem, one that explains every observation.	4	3	2	1
8. Learner proposes corrective action that is rational and eliminates true cause (when possible).	4	3	2	1

Key

4 =	Met and/or surpassed criteria
3 =	Met criteria
2 =	Showed progress toward meeting criteria
1 =	Did not meet criteria

Bibliography

Cusack, R. (2009, June). Rethink your liquid-liquid separations. *Hydrocarbon Processing*, 53-60.