Surface Facilities for Oil and Gas Handling

Prof. Abdus Samad

Department of Ocean Engineering

IIT Madras

Flow Control-01

The clarification on the level of detail in the differences between PFDs (Process Flow Diagrams) and P&IDs (Piping and Instrumentation Diagrams) helps understand their respective purposes in the design and operation of surface production systems.

PFDs, as you mentioned, serve as a simplified representation, providing an overall view of the process flow, major equipment, and connections between different points in the system. On the other hand, P&IDs delve into more specific details, including line numbers, valve numbers, instrumentation, and other crucial information that is essential for detailed design, operation, and maintenance.

This distinction is valuable, especially for individuals involved in the planning, design, and operation of oil and gas production systems.

That sounds like a comprehensive approach to the course, focusing on PFDs and the design aspects related to fluid flow in oil and gas production systems. Leveraging content from reliable sources like Arlon's volumes adds depth and credibility to the course material.

If there are specific topics or areas where you'd like more information or assistance, feel free to let me know. I'm here to help with explanations, clarifications, or any additional content you might want to explore. Additionally, providing links or sources for further reading is a great way to offer students more in-depth knowledge on specific subjects. Let me know how I can assist you further in delivering a comprehensive and engaging course!

Understanding the symbols and notations used in PFDs is crucial for interpreting diagrams

effectively. It helps in quickly identifying different components and their functions. Here's a summary based on your description:

Valve: Depicted as a dumb groove or cross.

Check Valve: Represented as a one-way valve with an arrow.

Relief Valve: Illustrated with a specific symbol.

You also mentioned symbols for an air cooler, heat exchanger, and electrical coil:

Air Cooler: Resembles a fan-like structure.

Heat Exchanger: Depicted as a coil.

Electrical Coil: Represented as a coil.

These symbols are commonly used in process flow diagrams and are essential for anyone working in fields related to fluid systems, such as oil and gas production. If you have more symbols or aspects you'd like to discuss, feel free to share, and I can provide further information or clarification.

Details About Control Valves And Shut Down Valves:

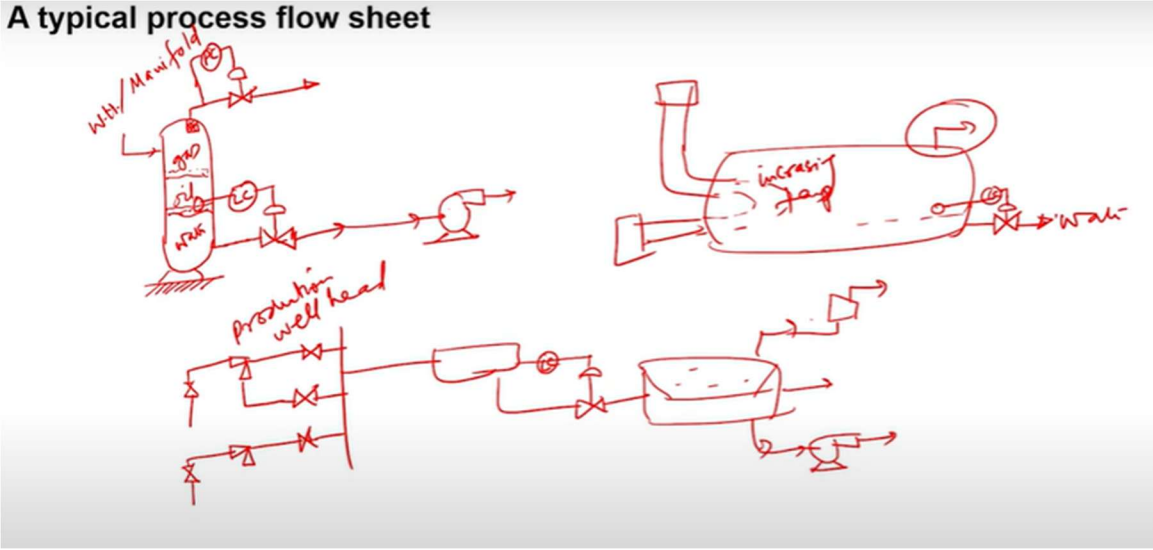
Control Valve (Flow Controlling Valve): Represented with a valve symbol and a top semicircle mechanism. Fluid enters, and the flow is controlled by turning the top portion.

Shut Down Valve: Depicted with a specific symbol to indicate shutting down the system. The design suggests its function in emergency shutdown situations.

These symbols are crucial in process flow diagrams to convey the functionality and operation of different components accurately. If you have more symbols or topics you'd like to cover, or if there's anything specific you'd like assistance with, feel free to provide more information.
Accuracy in using the correct symbols is crucial when creating process flow diagrams. Understanding and correctly representing symbols for valves, controllers, chokes, and other components is vital for effective communication in the field of surface production systems.

It's important to understand and correctly use symbols for various components in process flow diagrams, including those related to surface production systems. Symbols such as level controllers (Lc), pressure controllers (Pc), temperature controllers (Tc), flow meters (M or F), pressure vacuum valves, flame arrestors, and compressors are essential for accurately representing the components and their functions in the system.

If you have any specific questions about the design, operation, or any other aspect of surface production systems or related symbols, feel free to ask. I'm here to assist you with any information or clarification you may need.



So, you are giving high-temperature gas and you are changing the fluid viscosity of the inside separator. Later we will discuss when we discuss about fire tube boiler and fire tube how it is helping in separation. Whenever you are increasing temperature fluid viscosity will change. When viscosity is changing your separation rate can change. There is a main purpose and the pump also integrates part of your system surface production systems every many places there will be low pressure and you have to transfer fluid from one point to another point.

In that case, you use normally centrifugal pump sometimes another type of pump also can be used. The centrifugal pump normally will be a high-volume flow rate pump. Later we will discuss further details of centrifugal and positive displacement or reciprocating type pumps that will be there basically used for your surface of production systems operations. Centrifugal pumps have high volume, but pressure also will give you sufficient, if you

require very high pressure for example, gas lift application you need a very high compression ratio in that case centrifugal pump may not work centrifugal compressor or pump may not work for very high compression systems. For example, the jet pump you are using.

You need very high-pressure fluid you have to push into your wellbore or gas lift system also very high-pressure gas you have to inject into your wellbore. In that case, the centrifugal pump may not be working properly. In that case, you use a reciprocating type pump or compressor based on your fluid it may be liquid gas-liquid normally we say liquid case pump if we have gas we say compressor. The machine is the same you are giving energy to fluid using some mechanical means ok? A reciprocating pump or reciprocating compressor principle mechanical the same fluid mechanics if we analyze fluid mechanics it will have the same basic fluid mechanics same equations everything the same.

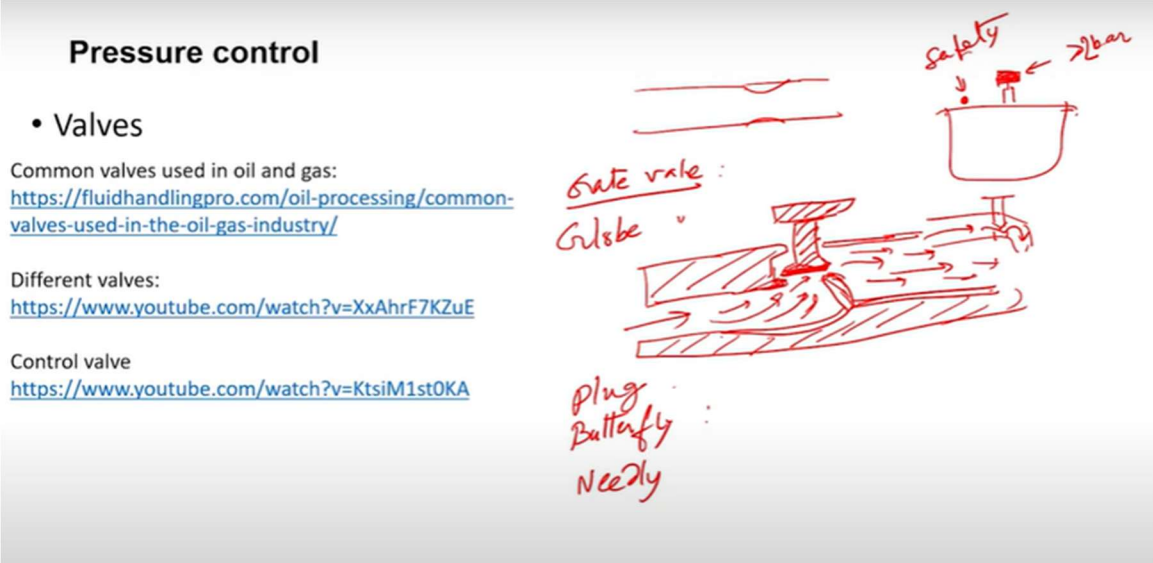
The main thing is that it is in the pump it is incompressible in the compressor term compressor. So, it should be compressible actually, but in many places, we do not differentiate cycle pumps or we say road-size cycle vendors will be there right? So, whenever you have cycle leakage or tube leaking and air pressure goes down. So, you have that reciprocating compressor that is a compressor, but you say a pumper. Although you are using a different term, the purpose is compressing you are increasing pressure right?

When you are increasing pressure your volume will be going down you are compressing, but actually, technically we should not use those wrong terms whenever you are pumping liquid. So, it is a good pump whenever pumping gas normally we say compressor fine. So, this figure is a centrifugal pump later we will discuss when the pumping systems. There you can see this is a centrifugal pump. For the reciprocating pump, I think they did not use any symbol this is a common symbol used for your surface production operation pumping systems when you are doing for PFD you can put this symbol safely.

We will assume this is a pump, but if you are using this compressor on this one. We will assume gas is there you are compressing, but a gas line if you are using a pump I will assume there is maybe some liquid. You should not use the wrong symbol. The pump symbol is like this centrifugal pump any type of pump also. If this symbol is there I will

assume this is liquid and you are pumping you are giving energy to the fluid, but if you are using the compressor symbol you are giving energy to gas or natural gas or air whatever gaseous form.

These symbols you should remember and another is there this is also a compression system this one, but we will see whenever we will be using these are whatever I marked check valve also here I have drawn right. These are the most common types of symbols used for the PFD application process flow diagrams. A typical process flow sheet. Now, that you have the symbols how to apply let us try to see. Let us say we have one vertical separator, the length is more than the diameter and it is placed vertically.



It is a vertical separator. So, normally we can make it like this, it is based on the ground and one inlet flow will be there it is coming from some wellhead or manifold right? Some manifold will be there because different wellhead well bores will be there. So, like wells 1, well 2, 3, 4 and different wells will have different pressures and different oil and gas ratios also the GOR. So, directly you cannot put all fluid in a single separator because if you are putting a single separator different pressure is there.

How to manage this one? You have to pass through the manifold and you have to control the pressure then you put it into your vertical separator or horizontal separator. Let us say the first stage I am giving one vertical separator this may not be true either or just it is hypothetical. And let us say you are separating gas. So, one mist extractor will be there

then gas is going there you have one valve this is valve right simple valve we have you can remember the symbol. Now this should not be a simple valve it is a control valve.

Normally control valve will be drawn like this pressure control valve this makes you right the P C pressure control valve. Based on that pressure also you are checking your controlling pressure. If I am putting a pressure control valve there then I will have this as gas right this is water because of density water will be the bottom portion and oil will be here and in between I can have some emulsion layer also I can have some foam layer I am not showing all these things now ok. I am making a simple drop diagram for PFD. Now when you are getting water you must have a level controller.

Level controller means LC then I will have one valve here. I am putting one level controller I will explain later how it is controlling level and so, if I am putting the wrong valve I will put zero marks. So, you should remember the type of valve where I am putting then this fluid is going to maybe another separator ok maybe somewhere there will be a pump for example, let us say I am putting one pump it may not be the exact thing in the actual scenario. That means I am handling liquid here, but in the gas line if I put this symbol same pump symbol that means, something wrong gas is having liquid or I have done the wrong drawing. This is a typical process flow sheet.

Some more separators and descenders and other things you can put, but you are controlling those symbols whatever you learn you should put all these things. If you are using let us say one horizontal separator with your heater heater heater right later we will discuss how this is working. In this case, you are using increasing temperature and you are getting let us say water here water directly you are not getting you must have a control valve right? I will not put a direct line rather I will put one control valve and only the control valve will not work I have to put some level controller right L C then you put the controller.

So, whenever you are getting water. The water level must be maintained properly if you are not maintaining then if water is too much down then the water pipe will get oil only if it is too high then water will go into your oil line only or fill liquid then the gas outlet and the gas valve outlet will have a problem. In every case, you have to use a controller. You can control your pressure and your flow rate you can maintain your pressure in certain sections. You can use some pump or certain sections you can use a compressor in many places where there will be low-pressure gases. Low-pressure well bore is there low-pressure gas is there.

In that case, maybe you have to increase pressure using some pumping mechanism or compressor mechanism. Then you are put into a separator in separating or you are making the if you have different well bores with different pressures and you cannot make a separate system for all the well bores first you have to make a unification you put it in a single separator then handle everything together. But if you say well 1 has 1200 pa separation well 2 is 500 and well 2 will have separators separate separator system well 1 will have a separate separator system is not possible it will be too expensive. So, you have to make only one system and all well bores will be connected via a manifold. So, that will be the basis of this process.

So, I will have one more flow sheet I will show you a different wellbore Let us say well bore 1 has one valve and it will go to this choke to the manifold. Then this will have another valve manifold well 2 also will have maybe the same valve will be there then choke. Several valves every place There will be several valves to control things. You cannot keep anything uncontrolled if there is any leakage somewhere you must cut off that area. You must have a nearby valve because of one leakage problem you cannot shut down the whole thing maybe you will be stopping that small area and replacing that pipe or tubing or you are rectifying the system.

You will have many valves and flow systems. These are manifold production wellhead and ah. This is a production manifold also. All together you are saying production manifold from there you are getting let us say one horizontal separator is here we have then we will have this water line maybe and the water line must be controlled again right? So, maybe this is L c then the water line will go to your flotation chamber maybe the right flotation chamber is the symbol for the flotation chamber.

So, flotation chamber from the flotation chamber water will be disposed gas will go to your gas line which means, this is a low-pressure system. Gas will have very low pressure. So, in that case, maybe you have to use a compressor again. How to use a compressor? You have to draw the compressor system right. So, you use a compressor then you put a main line ok and water whatever you are getting.

You may have to pump to transport to another place. You may have to put on the pump symbol here. You draw properly. You may have to use the pump symbol again you have to put labor controller pressure controller temperature controllers in many places in many

places you have to use another type of flow controller normally we do not control flow pressure controlling means it is controlling flow, but if you are using then you have again you have to use that if you are using flow meter then you have to put flow meter symbol pressure gauge symbol.

All the symbols you have to use. So, if I give you any flow sheet you should identify what type of valve we are using where fine. Pressure control whenever we are talking about pressure control. Pressure control pressure will be controlled using different types of valves. Sometimes you are narrowing down your piping systems let us say you have one pipe you narrow down. If you narrow it down your pressure profile will change.

Many times you have to use separate valve arrangements for example, your tap water is there at home or your hostel. You are turning and you are controlling flow during coronavirus time pedal operated valve also you saw right using your leg you just press something and your flow will be controlled you have a pressure cooker at home right pressure cooker in India normally used, but the western country they fear the pressure cooker is very dangerous, but in India normally we use almost every household will have a pressure cooker. So, a pressure cooker means it will have one vessel right? So, you can draw different ways also ok and there will be one hole here and there will be one valve. So, the valve will be pressure controlled if the pressure goes beyond 2 bar.

So, the valve will be open and it will release the steam if you do not release the steam what will happen it can burst. So, if pressure is very high then it can be an accident there will be a safety valve also here somewhere if you have seen the lead of the pressure vessel pressure for vessel there will be safety valve safety if that needle valve is not moving up and not releasing pressure then safety valve will be working and that will release pressure and everything will be safe ok. So, this valve will be operating if more than 2 bar pressure more than 2 bar pressure it will be opening noise will come and gas will be released right. So, this is the safety valve, and the pressure control valve ok. So, a similar system must be in your separator system also if pressure is going beyond a certain amount then you must have a relief valve and the final one will be the safety valve means nothing is working the safety valve will be opening without anyone's control and it will make everything safe fine.

So, there will be different types of valves. So, another thing is that tap you have household tap right or hostel everywhere you have seen this some tap will be there and you rotate the knob. There what will happen you have a pin ok and fluidity flowing through this if you

turn it turn it. That small area let us say fluid is flowing through this and you have a pin and you are turning. So, the pin will close the path if you turn in the opposite direction.

So, the pin will be moving up. So, fluid will be flowing continuously if you try it like this. So, the pin will be closing this flow path when closing the flow path fluid will not flow this pin type. So, close control is possible. So, sometimes you need a very small amount of water to wash your hands sometimes you need a very dirty hand is there.

So, you want to open everything. So, the flow rate will be higher. You can control flow also you are stopping plus controlling both you are doing. So, in many cases, you are giving close control. One bottle you want to fill. Opening complete a valve is not suggested small amount of opening is there then you fill the bottle other splashing will be there you cannot fill it right.

Different types of valves are there for different applications one is there a shutdown valve. So, if something goes wrong whole system will be cut and the system will be safe another is the pressure relief valve. Pressure is going up it will be releasing pressure and it will make the system safe. The different types of valves are like one called gate valve gate valve. Gate valve means Like you have one I will make let us say this is my pipe this is not good I will take another let us say this is my pipe.

And this is like a gate from the top you gradually linear you give linear motion to close it. Fluid is flowing through this now fluid will not flow this is the gate valve ok it is giving only linear motion. Just create a dam we have seen the right gate will be there like this vertically you are moving down and up. Up means this flow is continuous there is no stoppage of flow and if you want to stop flow move it down done close this is the gate valve.

The next is globe valve globe valve. So, the globe valve is like this it will be like this ok. What does it look like? So, you see this is the valve knob ok open the stop on this valve ok. So, if you move up and down. So, fluid is flowing through this arrow you see the fluid flow direction.

This is fluid flow. Fluid will be flowing like this and if you move it up the valve it will

open the path fluid will be flowing if you move down again it will be closing right. So, this one will be closing and opening this ok move up and down it will be closing. So, this is called a globe valve. In different orientations you just are restricting flow another is called the plug valve then the butterfly valve will be like this I have one pipe and one valve is here just turn it when I am turning it you see this fluid can flow easily and if I turn it like this closed just 90-degree turn.

If you give a 90-degree turn it will flow closed. A butterfly valve is normally used for bigger pipeline systems or bigger dams or somewhere it will be very easy to control because 90 degrees just turn 90 degrees flow stops again turn 90 degrees again it will start flowing this is called the the butterfly valve. Then, needle valve, plug valve you have one stem like this and rotate it will be closing path again rotating up it will be closing. The needle valve also has similar functions, but they will be controlled more precisely in the needle valve. So, needle valve we have one needle, and your flow path will be controlled more precisely this is called needle valve. Needle valve then I have pressure relief valve you should remember the names of different types of valves and one or two lines about why it is using how it is working that will be ok because you are not very much an expert in valve only.

So, when if you are working on surface production systems operations or production as a production engineer you should note the names of the valves ok you should not say I do not know. You have different types of valves someone is saying sir I need one butterfly valve. You should not see a butterfly flying like this how it can be Valve right? So, people are using the terms here. You should remember gate valves, globe valves, plug valves, butterfly valves, needle valves, pressure valves, pinch valves, and many other types of names.

These valves are used for your surface production systems. Valve definition is that it regulates and controls the flow control it regulates and controls the flow and pressure control the flow and pressure.