Advanced Control
Simple Pressure Controllers

Example 1:
At the inlet of most petrochemicals and process plants there is a knock-out drum whose function is to separate the water droplets from the gas stream. The pressure of exiting gas should be regulated and controlled which is suitable for downstream process.
Now we know the process and we should specify:

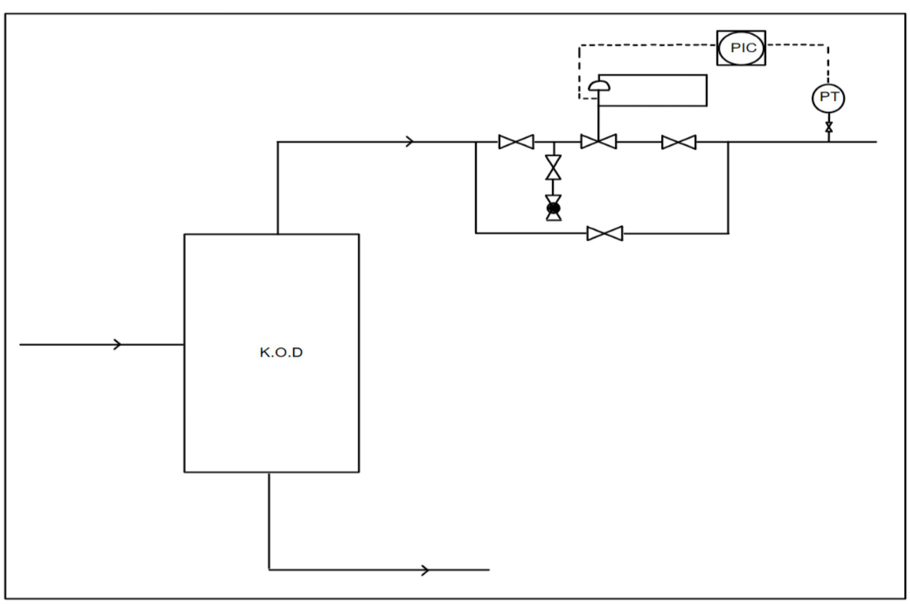
1. The type of control system (simple, cascade, split-range, override and complex)
2. The parameter which should be controlled
3. The configuration

For the first one, one can simply reach the following conclusions:

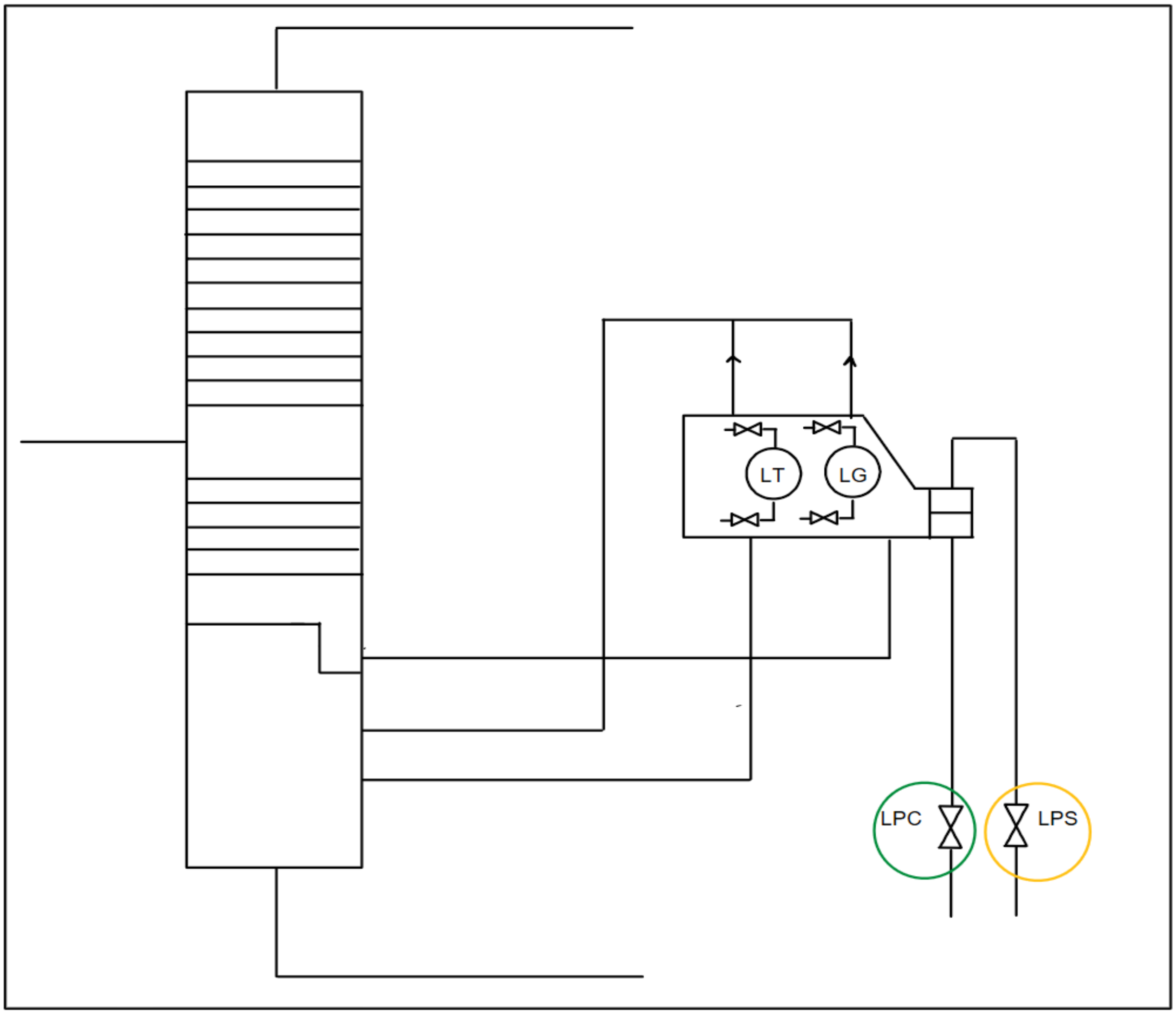
1. We don't need to implement split range since only one parameter impacts the performance.
2. We don't need to implement cascade control since PIC is fast enough.
3. We don't need to have override control since we don't have two controllers here to compare their output and select the safest one.
4. The control loop does not incorporate above control types and the system itself is not that much complex, so the complex loop is not needed here.

So finally, we select simple control loop. Regarding the second question, now it is crystal clear that pressure should be controlled. Thus, we need a PIC.
Lastly, we need to determine the configuration. To complete the configuration, we need to:

1. Show PIC on the P&ID
2. Show PT on the P&ID
3. Show the control valve and its assembly
4. Connect them together like below



Example 2:
Reboilers are unavoidable parts of distillation columns, whose function is to provide heat and vaporize the mixture. Reboilers are shell and tube heat exchangers with kettle configuration.
Here is the PFD-like sketch:



It is crystal clear that we should control the duty and the only way to control it, is the control of LPS.

There is a general rule among advanced control designers, that is we use PIC for control of duty of shell and tube heat exchanger in general and reboilers in particular. The PIC should control the pressure of LPS, so the control valve should be put in yellow location.

Why PIC instead of FIC is selected? The PIC is fast in action and basically plays with thermodynamic of the steam. It means the PIC changes suddenly the thermodynamic conditions such as pressure and temperature and maximize the heat and energy transfer. This is useful specially during start-ups.

Now we know the process and we should specify:

4. The type of control system (simple, cascade, split-range, override and complex)
5. The parameter which should be controlled
6. The configuration

For the first one, one can simply reach the following conclusions:

5. We don't need to implement split range since only one parameter impacts the performance.
6. We don't need to implement cascade control since only the PIC is fast enough.
7. We don't need to have override control since we don't have two controllers here to compare their output and select the safest one.
8. The control loop does not incorporate above control types and the system itself is not that much complex, so the complex loop is not needed here.

So finally, we select simple control loop. Regarding the second question, now it is crystal clear that pressure should be controlled. Thus, we need a PIC.
Lastly, we need to determine the configuration. To complete the configuration, we need to:

1. Show PIC on the P&ID
2. Show PT on the P&ID
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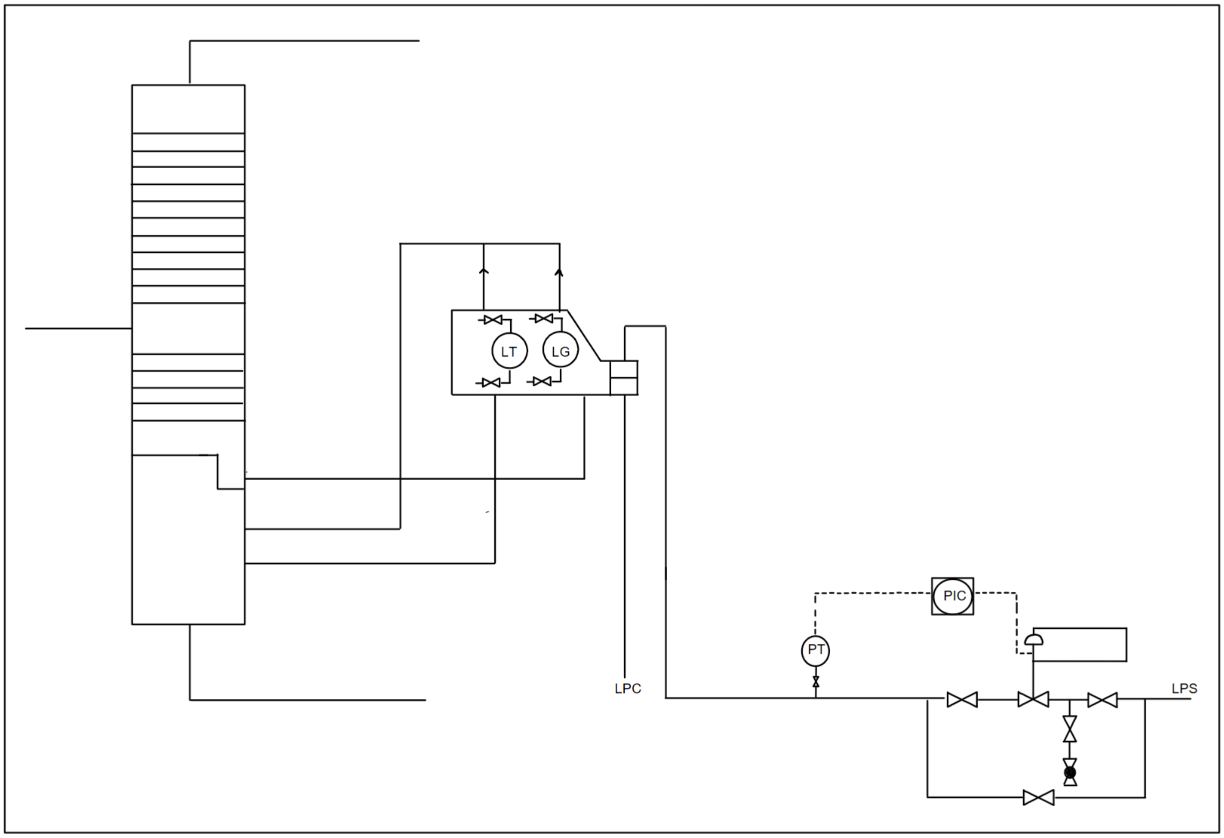
4. Connect them together like below

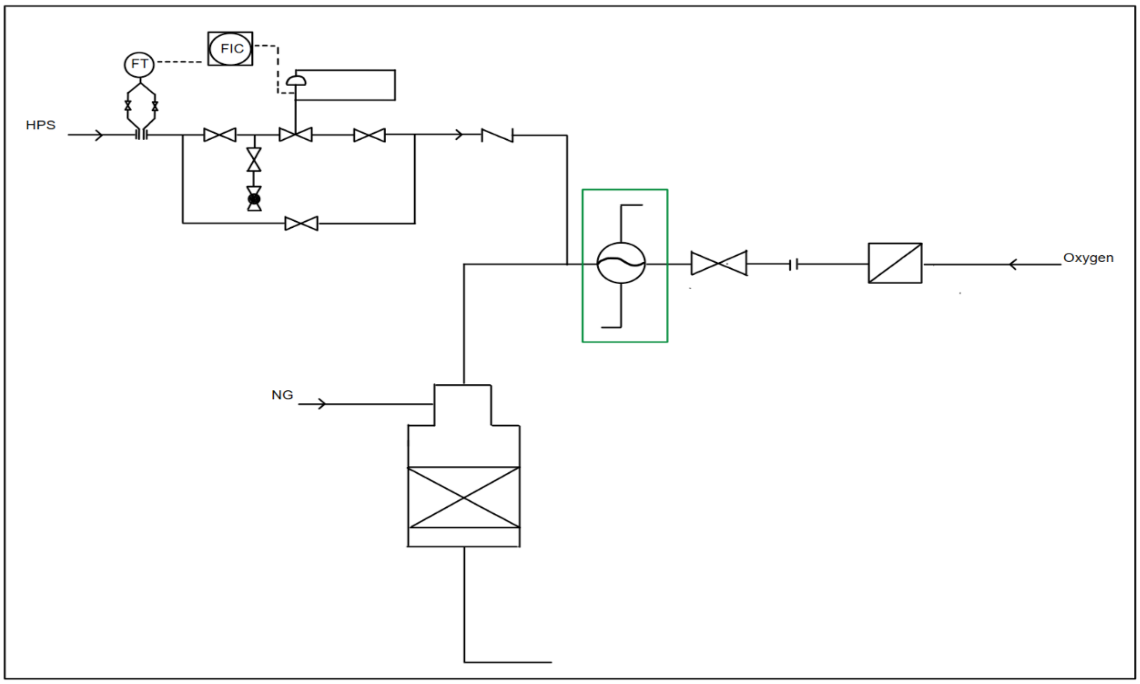
Note 1: When we use PIC or FIC at the inlet, the control valve size becomes bigger.

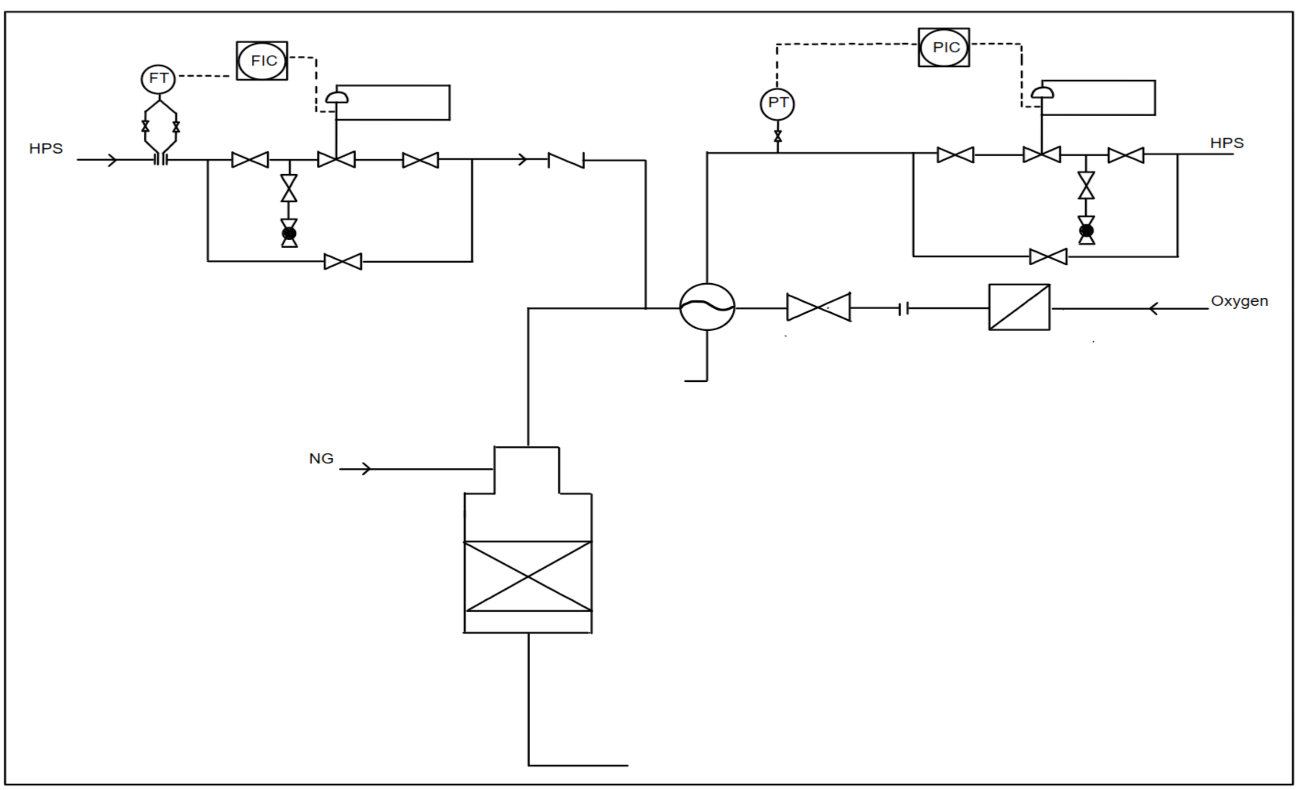
Note 2: The condensate flow is unstable.

Note 3: If the condensate is to be re-used in for example deaerator, the FIC is located at the outlet to stabilize the condition.

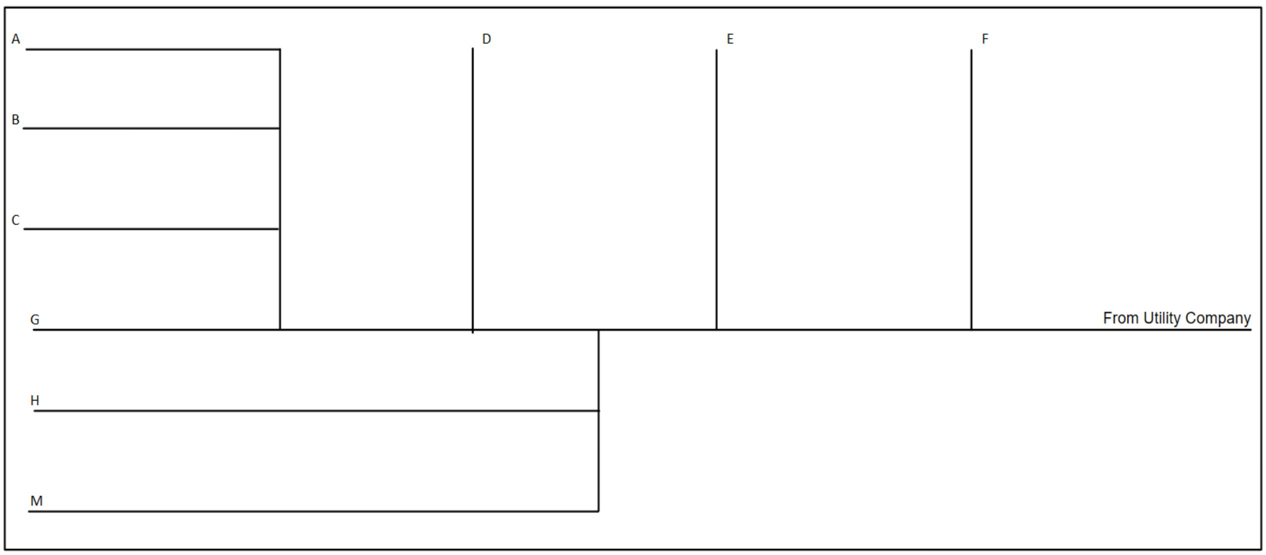

LT
LG
PIC
PT
LPC
LPS

Example 3:
Specify the control system for oxygen preheater in the oxygen application we talked about in second example.





Example 4:
Importing and exporting steam is typical almost in all process plants. During start-ups the steam is imported from utility companies while during 100 % capacity of production, petrochemicals export their excess steam. Based on our experience, we can say that when the capacity goes above 75% to 80%, the steam becomes excess for that capacity. The exported steam comes from a header which is shared by other process plants as well. The criteria to check that the header is in healthy condition and in good shape, is its pressure. You know why? When the pressure is high, it means it can pressurize internal steam headers of all process plants. Here is the sketch:



Now we know the process and we should specify:

7. The type of control system (simple, cascade, split-range, override and complex)
8. The parameter which should be controlled
9. The configuration

For the first one, one can simply reach the following conclusions:

9. We don't need to implement split range since only one parameter impacts the performance.
10. We don't need to implement cascade control since PIC is fast enough.
11. We don't need to have override control since we don't have two controllers here to compare their output and select the safest one.
12. The control loop does not incorporate above control types and the system itself is not that much complex, so the complex loop is not needed here.

So finally, we select simple control loop. Regarding the second question, now it is crystal clear that pressure should be controlled. Thus, we need a PIC.

Lastly, we need to determine the configuration. To complete the configuration, we need to:

5. Show PIC on the P&ID
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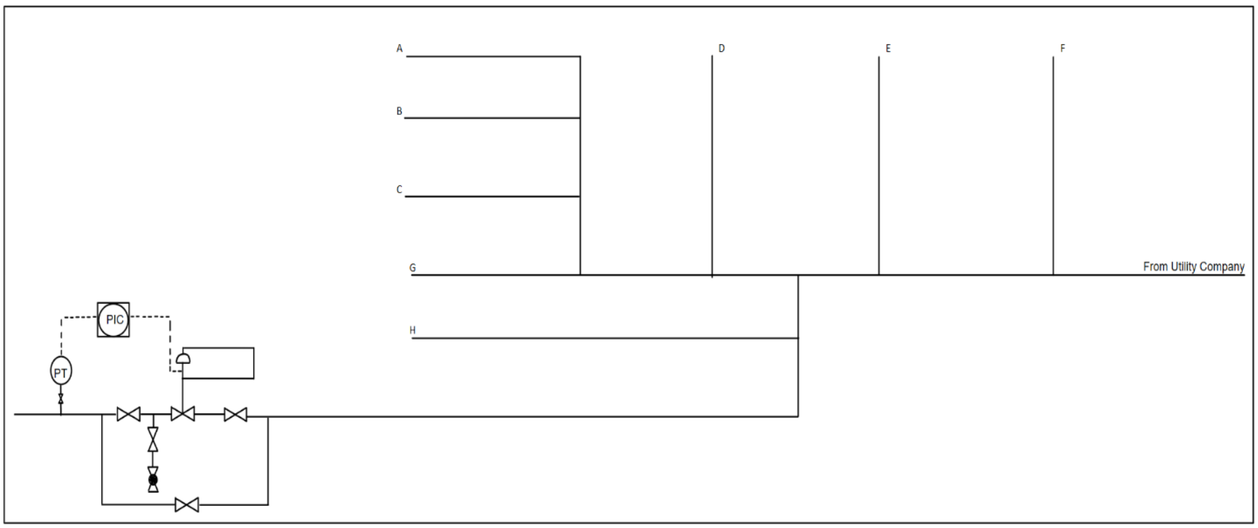
8. Connect them together like below
9.

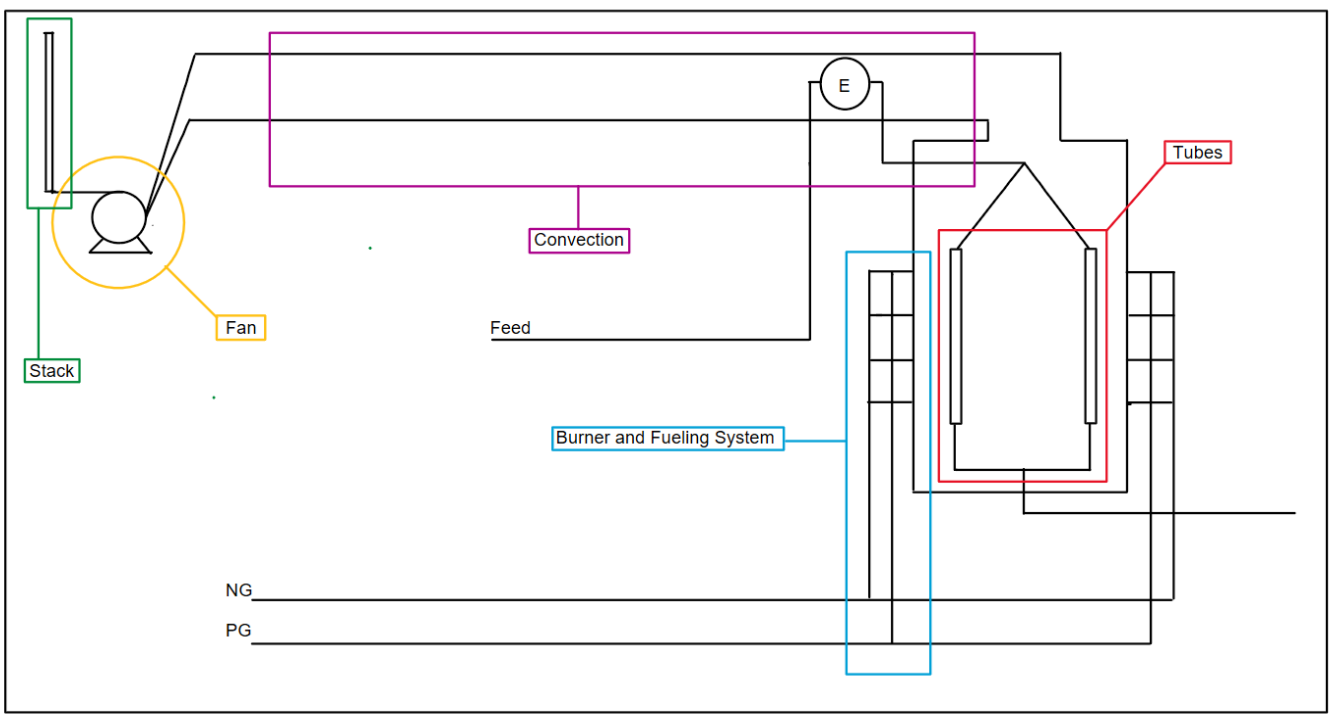


Example 5:

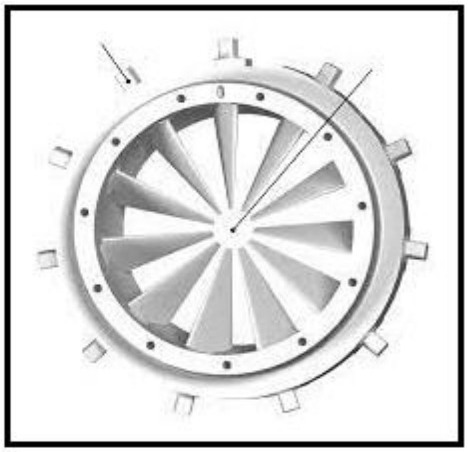
Most fired heaters have forced fan to push the air inside and have induced fan to take out the combustion stream. The drought pressure is the most important parameter which should be checked continuously by control operators. The drought pressure should always be kept within a range, typically -20mmWG < P < +5mmWG. The reason it should be kept above -20mmWG, is that the lower pressure damages the refractories. In a simple way, it dispositions the refractories and bricks. The reason why it should be kept below +5mmWG, is that the combustion stream with above pressure might find a way to the atmosphere and injure site operators.

As stated, the drought pressure is controlled by means of fan which is driven by a motor alone or a turbine alone or combined motor and turbine. For now, we suppose the fan is driven by a motor alone. Also, the amount of air which should be taken out is controlled by rectangular openings. The openings are controlled by inlet guide vane or IGV. When the IGV closes the amount of flow going to stack reduces and as a result there would be more combustion stream behind closed door! Which finally leads to increase in pressure. When the IGV opens the amount of flow going to stack increases and as a result there would be less combustion stream behind closed door! which finally leads to decrease in pressure. The conclusion is that IGV acts as pressure control valve or PV.

Here are two pictures to help you better understand the above explanation.



Inlet Guide Vane



Now let's focus on the control system.

Now we know the process and we should specify:

10. The type of control system (simple, cascade, split-range, override and complex)
11. The parameter which should be controlled
12. The configuration

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13. We don't need to implement split range since only one parameter impacts the performance.
14. We don't need to implement cascade control since PIC is fast enough.
15. We don't need to have override control since we don't have two controllers here to compare their output and select the safest one.
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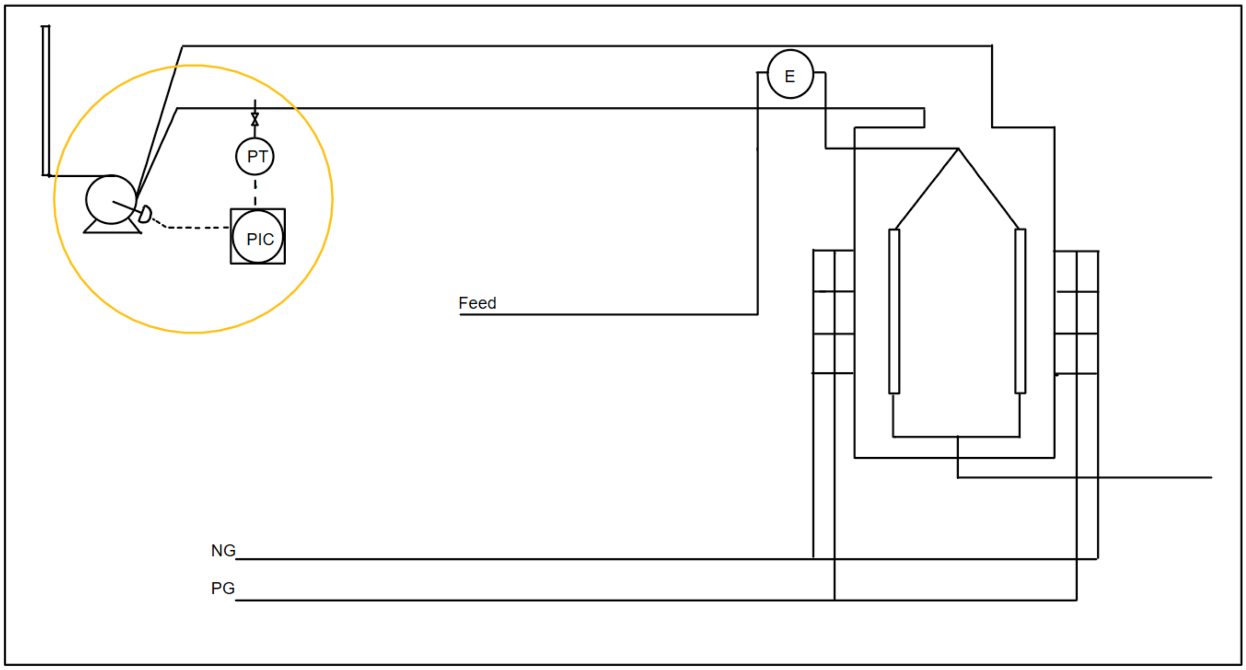
E
PT
PIC
Feed
NG
PG