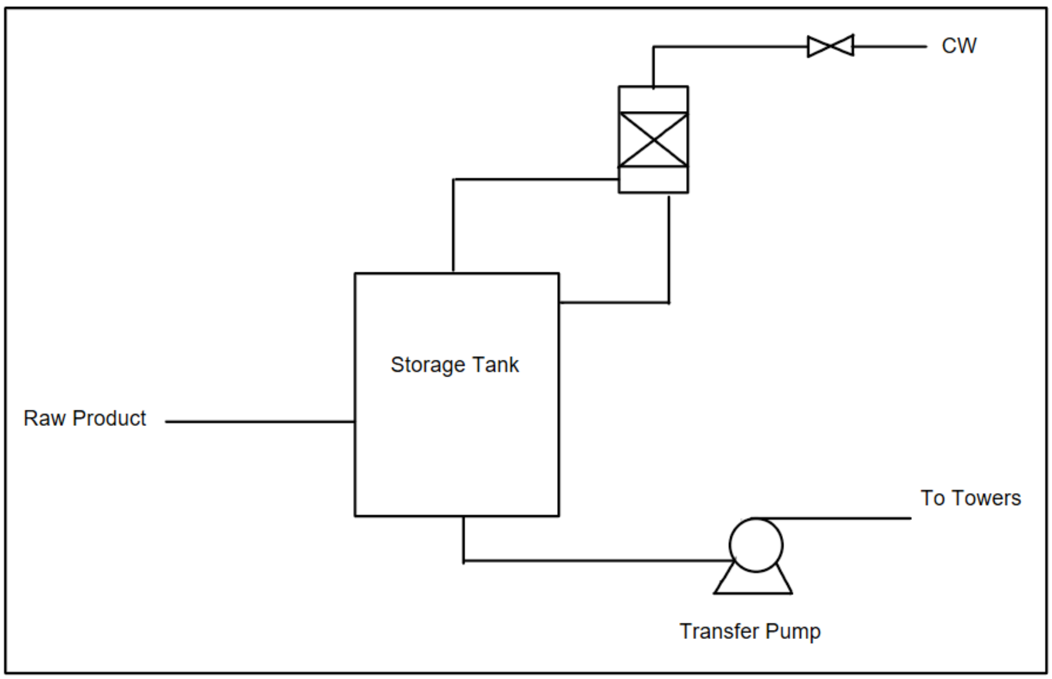
Advanced Control

Simple Flow Control Loops

Example 1:

It is common practice in oil and gas industry that when we have unpurified product, then the product is sent to distillation column to be purified and the grade of the product is improved. In order to avoid any disturbance at the inlet of the distillation unit, there is an unpurified product storage tank. Since the tank operating pressure is atmospheric due to economical analysis, then a part of the product is flashed. In order to get the flashed product back to the liquid state and mitigate the loss, a packed column is used on the storage tank so that the flashed product comes to contact with cooled water over the packings and as a result, the flashed product is washed and comes back to the liquid state. Here is the PFD-like sketch:



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

To answer the first question, we should delve into the design of packed column. Don't worry, we are not going to talk about that much details.

The existing packed column is countercurrent and its performance is determined mainly by the surface area and the flow of cooled water. In fact the higher the surface area and the higher the flow of cooled water, then the higher the amount of the flashed product would return to liquid state.

The surface area during design is fixed and as a result, the only parameter which should be controlled is flow. Therefore,

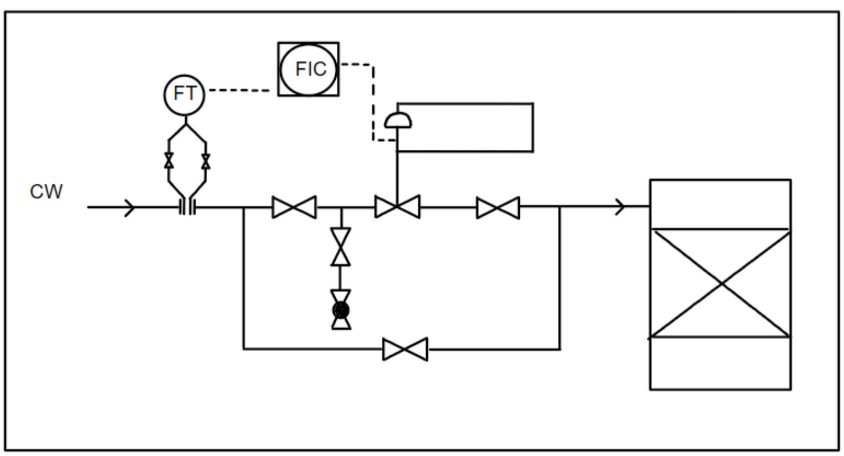
1. We don't need to implement split range since only one parameter impacts the performance.
2. We don't need to implement cascade control since flow controllers are the fastest.
3. We don't need to have override control since we don't have two controllers here to compare their output and select the safest 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 flow should be controlled. Thus, we need a FIC.

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

1. Show FIC on the P&ID
2. Show flowmeter on the P&ID and locate it before the valve
3. Show the control valve and its assembly
4. Connect them together like below



Note for flowmeter selection:

Application	Flowmeter Type
Gas station	Ultrasonic
Fuel system	Ultrasonic-Turbine-Vortex
Fluid with high amount of conductivity	Magnetic
Fluids with conductivity less than 5 us/m	Vortex
Low pressure gases	Venturi
High pressure steam services	Flow nozzle
High erosion present	Flow nozzle
Battery limit-Product	Coriolis
Process unit where controlling parameters is a high priority	Orifice

Example 2:

In ammonia and methanol plant, Syngas which is a mixture of H_2 + CO + CO_2 is produced is produced by ATR technology or simply auto thermal reactors which principally based on mixing and reaction of NG and oxygen to produce heat required for catalytic zone. The burner in which oxygen and NG mix and produce flame has special material. As a result, the tip of the burner should be maintained as specific temperature so that the damage to burner is prevented.

To maintain the temperature, simply HPS could be added to the oxygen, not only to reduce the oxygen concentration and avoid any explosion, but more importantly to cool the burner tip.

Based on CFD analysis the maximum flow of 4000 kg/hr. of HPS should be added to oxygen. On the surface, a TIC controller with TV valve would do the job and keep the temperature within the range. When the capacity of NG and oxygen change, the TIC can lower the opening of the TV and reduce the flow since less flow is needed. But how about this: We maintain the flow at 4000 kg/hr. at all phases with one main reason, which is the safety of the burner since the TIC control can possibly cause some fluctuations and lead to the damage to the burner. Keeping this in mind, we need a FIC.

Now let's take the same procedure and develop the control loop.

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:

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 the FIC is the fastest.
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.
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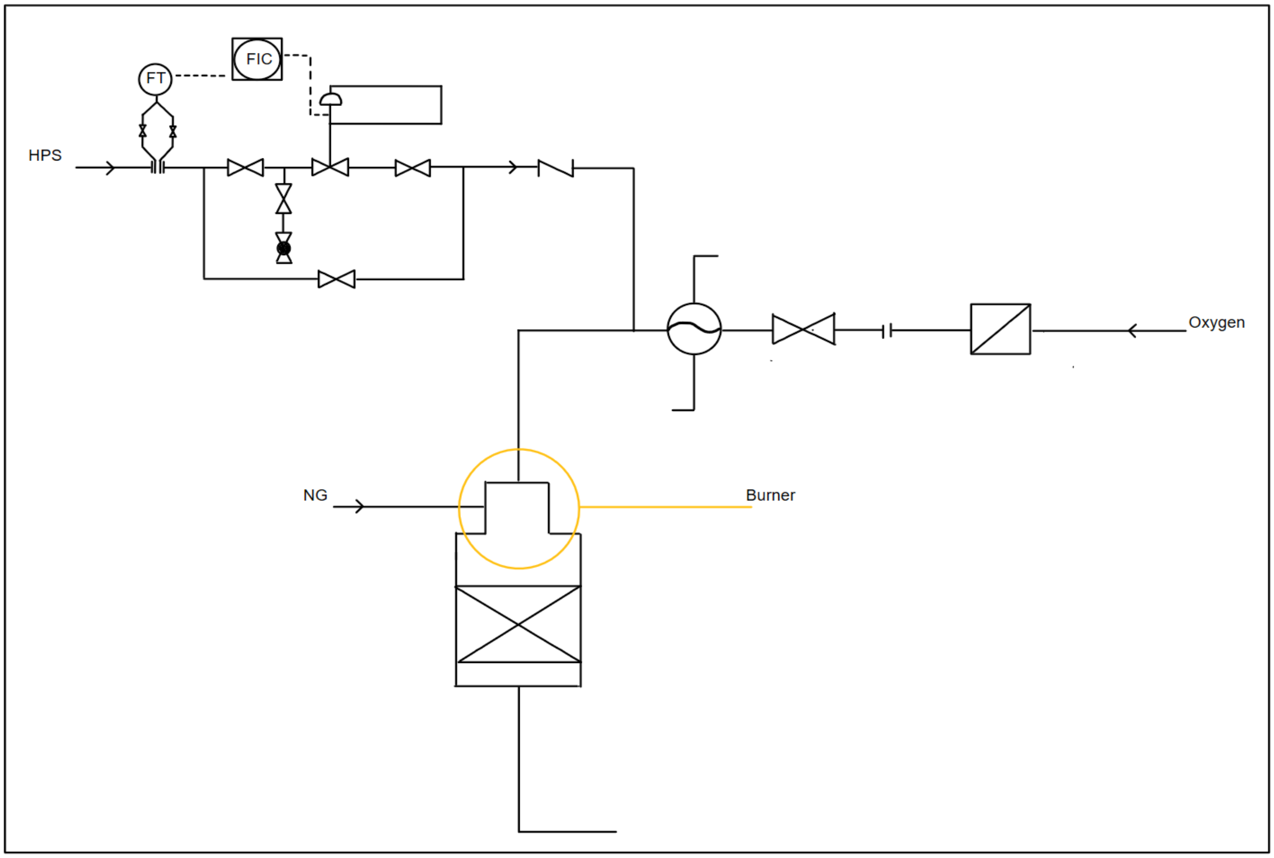
FIC
FT
HPS
Oxygen
NG
Burner