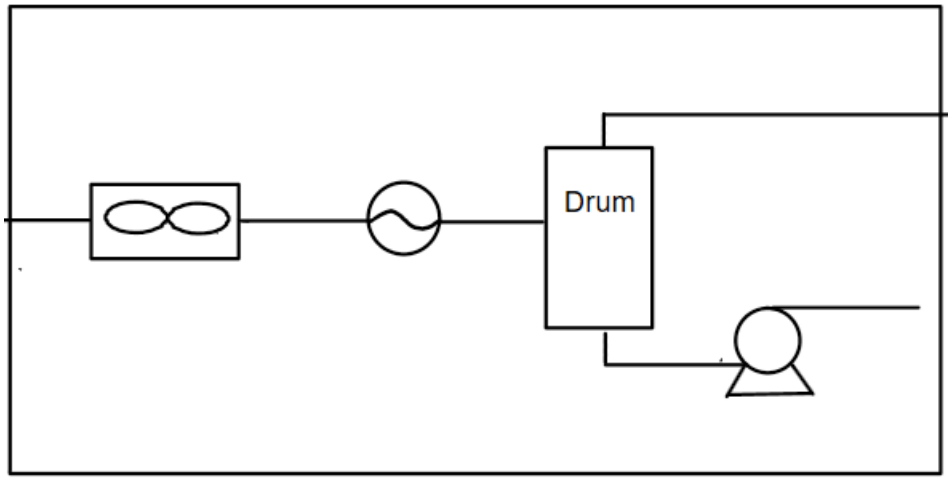
P&ID Development
For Gas Cool Train

Here is a part of PFD that we developed during PFD development:



For today let's create and develop the P&ID:

1.Air coolers

Since they are driven by motor, then we show the assembly like below in P&ID.

We have headers to distribute the gas to different air coolers. So in P&ID, we just use

After the air coolers we have condensate, which means that we need to have the piping with some slope to direct the mixture to the next equipment.

We need also a temperature transmitter to monitor its outlet temperature, which is obvious.

2.Water-cooled heat exchanger

Most shell and tube heat exchangers need a vent and a drain.

CWS-Cooling Water Supply- comes from lower nozzle and gets heated and exits from upper nozzle. That's a rule.

In contrast, the hot Syngas gets cooled, and as a result, becomes more densed, and exits from lower part.

Based on detailed design of heat exchanger, we need TEMA H type for its shell, which means that we need to divide the Syngas to two lines connected to the heat exchanger. Since we have to maintain the mass balance, then we will have:

$Q_1 = Q_2 + Q_3$

$V_1A_1 = V_2A_2 + V_3A_3$

$A_1 = A_2 + A_3$

$D_1^2 = D_2^2 + D_3^2$

$32^2 = 2D^2$, D = 24''

Finally, as stated before since here we have condensation process, then we need to slope the pipe.

We use butterfly valve for manual control of cooling water.

Near each butterfly valve we need to add a drain valve

Regardless of the project, we always use a PSV for hydraulic expansion scenario

3.Separators

For separators we have to illustrate the followings:

1. Inlet type: Half open pipe
2. Mist eliminator if required
3. Vortex breaker
4. Gas outlet line
5. Liquid outlet line
6. Manhole
7. Level gauge
8. Level transmitter
9. Control system
10. Structure
11. Drain

4.Pumps

For pumps we have to illustrate the followings:

1. Isolation valve which is gate valve
2. Strainer-Filter
3. Drain between isolation valve and strainer
4. Pump icon and its driver
5. The driver of the pump is a motor. We need to have some info about its running status or any fault in the motor which prevents it from running. So we have to consider some instrumentation blocks to show them. Remember whenever the driver is motor, we have to do the same, regardless of being the driver of a pump or mixer
6. Pump drain and vent
7. Pressure gauge at the suction and discharge
8. Check valve
9. Isolation valve which is again gate valve
10. Pressure transmitter
11. Drain valve between isolation valve and check valve.
12. Control system

5.Control Valve

Since we have a separator, we need a control valve to control the level.

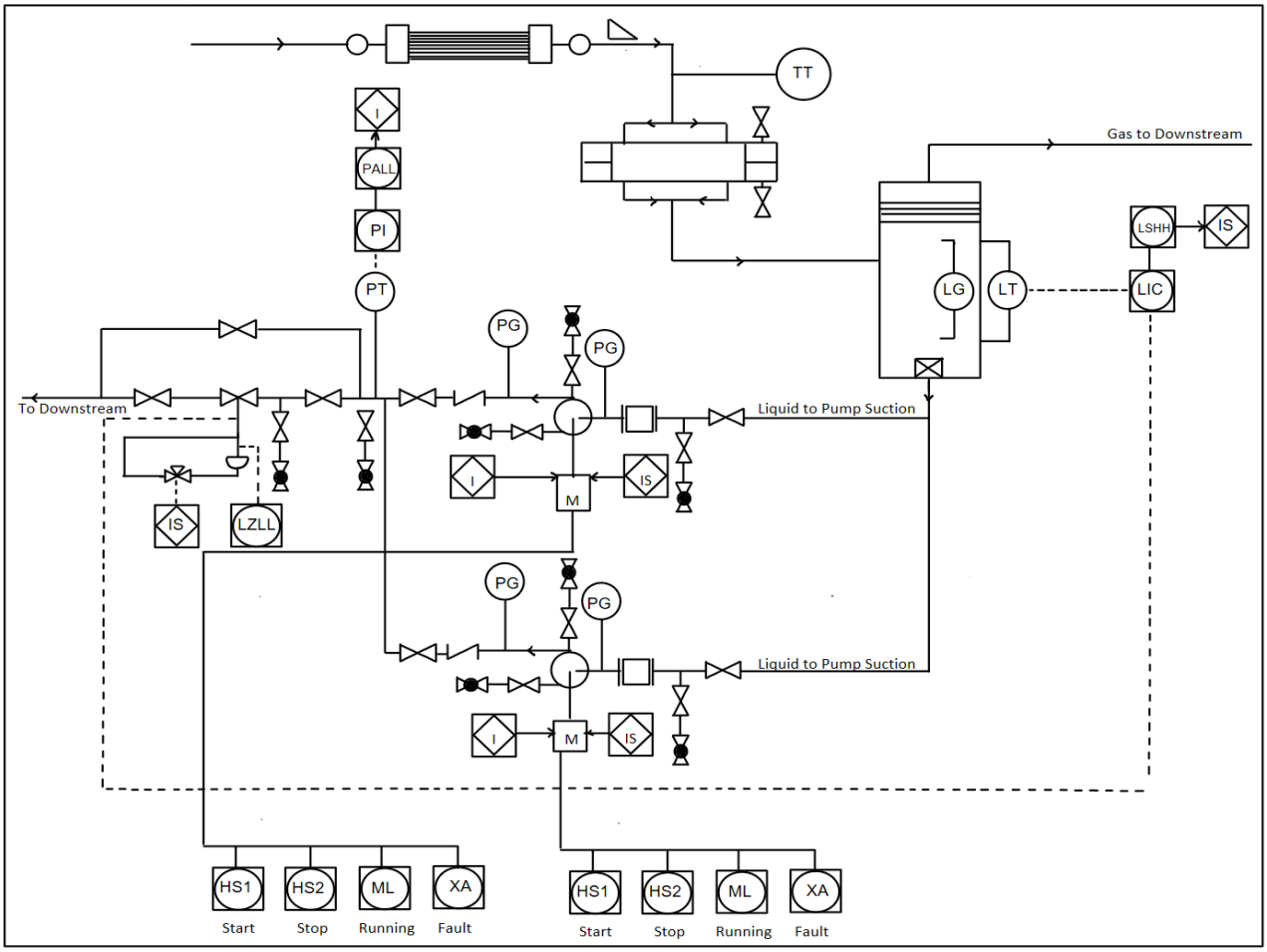
Each control valve has two inlet and outlet isolation valves which are gate valves.

Between the first isolation valve and control valve, we need drain valves.

We have to also specify the instrumentation.

Bypass valve size is selected based on following table, which is developed based on experience. Notice that it is like this that you size the valve based on some formula or the way we size a control valve.

Now, if we incorporate all above parameters into our PFD, then it would become like this:



Notice that here line information is excluded here to help your mind focus on what new is!

Appendix: Interlocks

General information about the trip systems

A number of instruments in the plant are equipped with passive alarms to warn the operators in the control room against deviating operating conditions, which may lead to dangerous situations or which may cause damage to the equipment or the catalysts.
Critical parameters such as essential flows, pressures and temperatures are provided with active alarms connected to the safety interlock trip system. Some of the above passive alarms are acting as pre-alarms for the active alarms.
These active alarms will initiate automatic safety actions to safely shut down certain process sections in order to protect the personnel and the equipment of the plant against hazards.
When a trip group has been activated, operators must act to maintain safe operating conditions in the plant.

Furthermore, there are a number of interlock systems, which activate a shut-down of pumps, start-up equipment and other equipment if process parameters deviate too much.

Due to a considerable higher cost of IS than DCS hardware, consideration has been given to define which actions (groups) are to be performed in the IS system and which actions are to be performed in the DCS. Action performed in the IS are called IS-group (Interlock Safety) and actions performed in the DCS are called I-group (Interlock). In order to establish guidelines for the distinction of those actions, the following rules are applied:

Trips in IS groups are generally based on 2-out-of-3 voting.

IS-groups must protect:

- personnel against safety hazards
- critical plant equipment
- unit trips which will result in a significant production loss when initiated

I-groups must protect:

- auto start and stop of motors
- avoidance of PSV relief
- switching of operating mode