Commissioning and Start-up / Shut-down of the ethanol production plant

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Abstract. This paper work demonstrates the commissioning and start-up/shut-down processes of the ethanol production plant with reagents 88 % IPA (isopropylalcohol) and 12 % water. Moreover, this research paper gives schematically illustrates the fabrication of methanol production over 100 ton per annual. Besides, the most important aspects of commissioning, pre-commissioning categories and activities are indicated within this research work.

1. Introduction
With the continual focus on production efficiency and increasing the complexity of control systems, the knowledge of the processes and the process equipment has become an important part of plant design. Therefore, transferring of the new plant installed hardware in operational facility refers to the plant commissioning. The first job of process plant commissioning is to prove the ability of the plant to be able to operate as in the designed operating process. There will always be unknown factors, so attention is required into the first start-up then into subsequent start-ups and shutdowns [1]. Experiences gained during the first start-up will be used by plant operators, for future plant shutdowns and start-ups. Delay with start-up causes issues with investment, as the revenue stream is extended and difficult start-up adds to the cost of investing the project. Most important aspects of commissioning are: planning (requirements of the commissioning must be considered in the construction planning), experienced personal (workers must have appropriate knowledge about the operating process, especially they must be well familiar with hazardous nature of the chemicals) and synthesis approach (individual responsibilities on the plant process must be assigned to operators with detailed information relating to the operating conditions). [2] In this section, the main activity will be involved for pre-commissioning, as the effective management for the start-up is required.

2. Pre-commissioning
The idea of the pre-commissioning is to make sure that (before feed inlet is pumped to the reactor) all equipment is installed properly and matches to plant design specifications. While the pre-commissioning operation, all temporary line must be tested and tie-ins to the existing system. The most important stage of the pre-commissioning includes: [4]

Cleaning of the equipment – it is the removing stage of all loose material and adherent material that can become detached during the operation process of the plant. The cleaning process should be applied
to pipes and tanks that operate in a plant where, the construction contaminates must be removed. The gas headers cannot be cleaned with water, so they should be cleaned with hoses.

Pressure testing: all vessels and pipes must be tested according to the plant design, especially in the presence of shop-fabricated elements. So, the joints of the pipes/vessels must be verified for tightness. Pretesting of the site pressure can be done by using water (hydrostatic pressure) or by air (at high pressure), pumped through pipes and vessels. The usage of hydrostatic testing is safer compared to other, since large compression energy is released during the escape of the compressed air. Moreover, the hydrostatic pressure mostly carried out at higher pressure than the system operating pressure, so the ability of the plant system for higher pressure is checked as well. As in this case, water is used during the reaction process, so the hydrostatic testing should be done on the process plant.

The pressure testing must be stated in the commissioning plant and it usually takes 30 minutes. In case of leakage, the pressure must be reduced and only then the fixing action should be taken. The water used in the testing is treated as waste and discharged to the river.

3. Commissioning

The process of commissioning ensures that a plant operates as it is designed to. It is performed before a plant begins operation so as to decrease the chances of unforeseen eventualities. According to the HSE website, plant commissioning activities fall under the following categories:

- System Configuration check – this entails a visual inspection of pipework and connections to ensure that they are clean and configured as intended
- Instrumentation System Check – this ensures that all alarms and trips are functional
- Flushing and Cleaning of Lines and Vessels – in this stage, water is used to clean pipes and vessels to prevent contamination and potential blockages which may occur once production begins
- Assessment of Ancillary Equipment – this step checks to see if all ancillary equipment (fans, pumps, condensers, heat exchangers etc.) are fully functional
- Calibration of Vessels and Instrumentation
- Start Up Protocol – this guides operators on how to bring installation online
- Shut Down Protocol – this guides operators on how to take the installation offline
- Chemical Trials – in this stage, chemical reactions are simulated in the intended operating conditions so as to ensure proper functioning of the installations
- Handover

The schedule below shows in a sequential way, how this group would commission the acetone plant before start up (Table 1) [4].

**Table 1. Pre-commissioning activities.**

| Pre - Commissioning Activities | Comments |
|-------------------------------|----------|
| Layout and P&ID Review        | Review overall plot of placement of major items such as V-1001, V-1003, F-1001, V-1004, V-1005, V-1006 and V-1008 and minor ones such as reboilers, pumps (P-1001,1002), condensers (CON-1001, 1002, 1003), accumulators (V-1007,1009) and heat exchangers (HE-1001, 1002, 1003). |
| Determine Equipment and Systems to be Commissioned from P&ID | All major equipments (V-1001, V-1003, F-1001, V-1004, V-1005, V-1006 and V-1008) and minor ones such as pumps condensers, accumulators and heat exchangers will be commissioned |
### Define Scope of Commissioning
Commissioning team will manage check-out construction work, procure initial fill of chemicals into utility and witness all flushing, instrument loop tests and checks and attend all design reviews.

### Recruitment of Commissioning staff and definition of team roles
Commissioning manager, commissioning system engineer, control/electrical/instrumentation commissioning engineer, mechanical commissioning engineer etc.

### Budget Estimation
Cost of operating and maintenance training, cost of cleaning and drying all major equipment.

| Risk Assessments and Hazard Study | - |
|-----------------------------------|---|
| Check that pipework from V-1001 to V-1003, F-1001, V-1004, V-1005, V-1006 and V-1008 are correct | In addition to visual inspection of pipework from major equipment, check that V-1001, V-1003, F-1001, V-1004, V-1005, V-1006 and V-1008 are properly bolted down |
| Clean pipes from V-1001 to V-1003, F-1001, V-1004, V-1005, V-1006 and V-1008 | Clean / steam blowing |
| Fill V-1003 with catalyst | Also check packing support grid |
| Check that alarms, flowmeters and trips are functional for For V-1003, V-1005 V-1006 and V-1008 | Water can be used to simulate the chemical reaction |
| Ensure that pumps, heat exchangers are functional | For P-1001, P-1002, HE-1001, HE-1002, HE-1003 |
| Commissioning Activities | Comments |
| Check for leaks in pipes 1 - 4, 6-10, 14 - 25 | Pipes are labeled based on the streams they carry. For example: Pipe 4 is the pipeline which carries stream 4 (from the vaporizer to the reactor) |
| Put all major and minor equipment online and commence start-up | Fill pipes with 88wt% IPA and 12wt% water. |

### 4. Shut-down and startup of the plant
When a plant is to be shut down for maintenance, all the equipment cannot be put offline immediately. There are many hazards that can occur if the plant is shut down immediately such as furnace explosions and pipe explosions due to pressure buildup. In order to prevent these from occurring it is necessary to employ good shut down practices. An example of a good shut down practice is to gradually lower the flow rate of the equipment at a rate that will be determined by the operator. This can be achieved by decreasing the pumping rate as well as the feed rate into the plant. Moreover, the pressure on the units also should be released (decreased). Another good shut down practice is to decrease the temperature of the reactor gradually from 450°C to room temperature. This means that operators should decrease the rate of burning of natural gas in the furnace, which will in turn decrease the amount of energy delivered to the molten salt per unit time, thus decreasing the temperature of the molten salt. After the flow rates,
pressures and temperatures are reduced to a level that is satisfactory (i.e. putting equipment offline will
not cause explosions or equipment damage) the plant items are shut down [5, 6].

5. Conclusion
In conclusion, the right steps in the pre-commissioning and commissioning stages are very important,
because the mistaken set-up can cause unwanted accidents or the system will not work properly. In case
of small error in the production plant, the result can be different to wanted product.

References
[1] Ullmann 2005 Ullmann’s Encyclopedia of Industrial Chemistry (Weinheim: Wiley-VCH)
[2] Bamatov I M 2017 Development of the chemical reactor V-STAR for continuous flow reactions
Chechen State University Journal 6 (2) 205-7
[3] Bamatov I M, Rumyantsev E V and Bamatov D M 2019 Development of the chemical reactor V-
star for continuous flow reactions IOP Conference Series: Materials Science and Engineering
537 032020
[4] Welley J 2010 Acetone VCCEP Submission (New-York: American Chemistry Council)
[5] Turton R 1998 Analysis, Synthesis, and Design of Chemical Processes (N.J: Prentice Hall)
[6] Styleanos S and Levy A B 2005 Acetone in Ullmann’s Encyclopaedia of Industrial Chemistry
(Weinheim: Wiley-VCH)