LNG Process and Design Issues and Considerations during LNG Plant Design - 2019

Since my re-immersion into LNG plant design and construction, I have found a need to review all aspects of the LNG plant Process Basis of Design and Basic Engineering Design Data (BEDD). As background, my career started as an LNG and natural gas process engineer and then I spend 30 years in the refining EPC area. I now have 40+ years in the oil and gas industry.

During the 30-year refining period, the project owner had refining and delayed coker standards and experienced project engineers involved all aspects of project planning, process design, and project execution.

In 2012, need for engineers with LNG experience led me back into the LNG industry, first as a Project Manager, developing new projects and proposals, and then in LNG Consulting and Expert Witness roles. In many ways, LNG plant design has not change and in many ways, it very different; new tank specifications, instrumentation and facility size to mention a few. FLNG adds another aspect.

Another difference for some new LNG plants, especially the smaller ones, is that they are being developed and built by entrepreneurial teams and companies who employed fewer experienced LNG engineers then I was accustomed to seeing in the refining business. Often these entrepreneurial companies rely too heavily on the EPC contractors' standard, which are okay, but certainly now specific to a specific owner's need.

Below, I share my 'first 20,' a list of issues which I use as a partial checklist, especially early in project bidding and development:

LNG Issues and Concerns during LNG Plant Design

Listed briefly below are issues to consider:

1. The process design basis is a CRITICAL document and it must be carefully developed. In particular, the feed gas composition used for the design is CRITICAL. <u>If a plant is designed for a typical natural gas composition and then a change in gas occurs, as new wells and/or economic conditions change, the change may cost significant plant design changes with associated cost and schedule impacts.</u>
   Although this seems obvious, it still 'catches' developers and operators:
   a. Mercury level and composition.
   b. Liquid hydrocarbon (ethane, propane, butane, etc.) composition.
   c. Carbon Dioxide levels. – Note that this is not just the highest level, but changes to extremely low CO2 levels can have a derogatory effect on gas treatment plants, if they are not design for these low CO@ levels.
2. The Client should develop the Design Basis and BEDD. If start with Contractors Basis, review if carefully for consistency with Client needs and expectations. In the end, the client is responsible for the Design Basis and BEDD sheets. Once he contractually agrees to the design basis, changes to the basis are generally to his account.
3. For Single Mixed Refrigerant (SMR) LNG plant,
   a. Confirm availability and cost of refrigerant. Note that there is usually a continuous makeup of refrigerant required.
   b. Do not pocket line in SMR lines carrying two phase flow (to avoid slug flow.)

    c. Startup power availability.
    d. Heat exchanger design, builders' experience, and refrigerant and gas distribution are critical. Often this is a coldbox or spiral wound exchanger which have limited capability for change after it is constructed.
        i. A normal designed LNG exchanger has the capability for continuous process removal of heavy hydrocarbon liquids.
        ii. Derimming.
        iii. Startup and shutdown valves, especially is long periods of shutdown are anticipated.
4. Ask if there is anything in the proposed design that is not proven and already in operation somewhere. Rarely will any improvement in efficiency justify the risk of unexpected design, cost, and operations issue associated with any 'first of a kind' or even for a minor 'tweak.' This is even more critical if the plant is to be operated in a remote area.
5. Recognize land needed for adequate plant design. Provide land (site) adequate for expansion and construction.
6. Recognize that the most efficient plant may or may not be the most profitable, that is, as in #4 above, a minor improvement in efficiency may not produce long term benefits, if the plant is difficult to startup, shutdown, operate, etc.
7. Learn what government requirements are. DOE, Environmental, local government.
8. Proven system (and licenses, if needed) for dehydration, CO2 removal, Mercury removal (if needed), Nitrogen removal (is needed), and removal of other components and contaminants.
9. Material selection.
10. Double block and bleed valves specified for plantwide, storage, pumps, and lines (especially to LNG tankers and truck.)
11. Safety. LNG can be produced safely, but consider the safety requirements, including handling of cryogenic materials, potential for a leak, handling and disposal of chemicals needed for CO2 removal, etc.
12. Design considering that, at sometime during the LNG plants life, freezing will occur within the refrigeration exchanger and develop design and operating manuals to allow derimming the exchangers.
13. Plate fin exchangers orientation and liquid vapor separation/distribution, if applicable.
14. Startup power inadequate for electric drive refrigeration compression.
15. Permit for environmental incomplete
16. FLNG is unique. Requires careful design to allow for wave 'rocking.' Distribution compensation for rocking
17. Plant layout does not provide adequate land and/or space for maintenance, fire protection, operations, etc.
18. Large baseload plants require many more services, especially consideration that they are often in remote areas.
19. Seismic criteria and design issues.
20. Understand the benefits of dynamic modeling. Often operators do not take advantage of ambient temperature changes to adjust operation to maximize LNG production.
21. I will get some 'push-back' here, but I believe that the best design is the simplest assuming proven. As the LNG plant get larger and staffed heavier, this may or may not always be true.

Successful project…

- Start out right.
- Have a reasonable budget and schedule.
- Client understands complexity.
- Reward careful early start rather than quick, cheap start.

I apologize it the above appears simple, but sometimes a list like this can help check design early on. AND I look forward to any additions or thoughts.

Best,

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