

JM ProcessWise webinar

Methanol and ammonia co-production

July 2021

Questions and answers

Please note that a number of similar and repeated questions have been combined.

Q1. What is the natural gas efficiency of the co-production flowsheet?

A1. The natural gas efficiency of the co-production flowsheet is dependent on a number of factors, for example the natural gas composition and product split between methanol and ammonia. However, the efficiency is expected to be in the range of 30-31 GJ/tonne methanol (LHV) or 28.4-29.4mmBTU/tonne methanol (LHV).

Q2. Why does the co-production flowsheet use a SMR and not oxygen based reforming?

A2. A SMR typically generates a syngas that contains approximately 3 hydrogens for every carbon oxide and for the production of methanol a ratio of approximately 2 is required, therefore the SMR generates an excess of hydrogen. For standalone methanol production this excess hydrogen represents an inefficiency in the process, however for co-production this hydrogen is a valuable feedstock for the ammonia unit. A standalone SMR flowsheet is lower Capex than an oxygen based reforming flowsheet for methanol production, however the advantage of the oxygen based reforming is that it generates a syngas with the right stoichiometric ratio for methanol production, which makes the process more efficient. The higher Capex of an oxygen based reforming flowsheet is offset by the improved natural gas efficiency and so it is advantageous in certain circumstances. For co-production however, the utilisation of the excess hydrogen means that the overall efficiency of the process can match that of oxygen based reforming but at a lower Capex, allowing a SMR based co-production flowsheet to achieve both high natural gas efficiency and low Capex.

Q3. What sets the maximum capacity of the co-production flowsheet?

A3. The maximum capacity of 6800MTPD is based on a production of 4100MTPD of methanol and 2700MTPD of ammonia. The maximum methanol production is set by the maximum size of the SMR that JM can build, which is an 864 tube reformer. The ammonia production is based on the optimum methanol to ammonia production ratio of 3:2. Ultimately it is possible to increase the

ammonia production above 2700MTPD if required by a client but this would result in modifications to the flowsheet that are likely to increase the Capex per tonne of product.

Q4. What's the best split of methanol and ammonia??

A4. As per the response to question 3, the optimum ratio of methanol to ammonia is around 3:2.

Q5. Is there any references?

A5. At large scale there are no commercially operating plants for co-production using any technology. However, one of the big advantages of the co-production flowsheet developed by KBR and JM is that it is based on two well proven technologies, each with numerous references. The modifications to those existing standalone flowsheets to produce the co-production flowsheet is minimal, meaning that the existing references are a very good reference for the performance of the co-production flowsheet. This also significantly improves the bankability of the KBR-JM co-production scheme.

Q6. Are there any emissions reductions (energy efficiency improvements), on a combined MeOH/NH₃ as opposed to two standalone units? I expect there is, but the real question is how much of a GHG reduction is there with the co-production flowsheet

A6. There is a GHG reduction for co-production in comparison to standalone units however the amount of reduction is dependent on the ratio of production of methanol and ammonia. For example a co-production flowsheet producing 3000MTPD of methanol and 4000MTPD of ammonia has a 6.5% reduction in GHGs compared to standalone units, whereas a flowsheet producing 3000MTPD of methanol and 1000MTPD of ammonia has an increased reduction of 35% in GHGs compared to standalone units

Q7. What is the capacity limit for maximum ammonia production?

A7. KBR offers stand-alone single train ammonia plants able to produce up to 6,000 MTD with a single converter.

When integrated with methanol production in the co-production scheme, up to 2700 MTD of ammonia can be produced without the need of a primary reformer: the combination of the hydrogen rich purge gas from the methanol synthesis and fresh natural gas generates in fact a mixture that is similar to the syngas fed to the typical KBR secondary reformer operating with excess of air. It is worth mentioning here that KBR Purifier ammonia plant operates with lower temperature in the primary reformer and higher methane slip compared to conventional technology due to the excess of air fed to the secondary reformer. That is possible

due to the use of the Purifier that remove the excess of nitrogen as well as any methane leftover and inert allowing the synthesis loop to operate at inert-free conditions.

It is possible to increase the ammonia production capacity in a coproduction scheme up to 6,000 MTD per single train and single converter by adding a small primary reformer to the fresh syngas that is mixed with the hydrogen rich purge gas from the methanol synthesis. In such a way not only it is possible to increase the ammonia production but the small primary reformer would add further flexibility in the operation of the ammonia production in case of stop of the methanol production.

Q8. The specific consumption for both ammonia and methanol production???

A8. This is again dependent on the product split between methanol and ammonia, but as an example for a flowsheet producing 3000MTPD of methanol and 1000MTPD of ammonia the natural gas consumption is 39.1 GJ/t of methanol (LHV) for the methanol unit, 23.0 GJ/t of ammonia (LHV) for the ammonia unit and 29.9 GJ/t of product (LHV) for the co-production unit.

Q9. Can they be operated independently, if there is a need, for short time?

A9. Yes, it is possible for the methanol unit to operate completely independently of the ammonia unit at full capacity. The ammonia unit can also operate independently but it will be at a reduced capacity due to the loss of hydrogen as a feedstock from the methanol unit.

Q10. What is the pressure of the syngas section and the ammonia synthesis?

A10. The typical pressure of the syngas section in the ammonia portion (from secondary reformer with air to purifier) is 30-40 bar. The pressure of the synthesis of ammonia is around 155 bar

Q11. How much flexibility is there to shift the production ratio between MeOH and NH₃

A11. At the design stage there is the possibility to design for most production ratios between methanol and ammonia as well as to add design features to allow increased flexibility to shift the production ratio during normal operation. An example of this would be to add a CO₂ compressor to allow the recycle of CO₂ back to the methanol unit. This would shift the production ratio to allow an increased the methanol production at a reduced ammonia production

Q12. Explain a bit more why a simpler CO₂ removal is possible. Does the higher CO₂ "slip" get converted to methane? Doesn't this require a larger Methanator?

A12. In JM-KBR co-production scheme, a portion of the hydrogen used to produce ammonia derives from the hydrogen rich purge gas from the methanol synthesis. Such portion of hydrogen does not "bring with it" the CO₂ that is typically generated in an ammonia standalone unit where all hydrogen is generated by reforming natural gas. In a typical JM-KBR coproduction configuration the total amount of CO₂ to be removed is around 30% lower than in a standalone ammonia plant. Therefore even with a slightly higher CO₂ slip, the methanator would be equivalent to the one of a standalone ammonia plant of the same capacity.

Q13. Can the CO₂ captured also be sequestered?

A13. Yes this is a possibility to reduce the emission of CO₂ to atmosphere.

Q14. Is there any way to use the CO₂ (in flue gas) from the SMR/reformer fired heater in the process to make CH₃OH

A14. It is possible to utilise CO₂ captured from the flue gas to make more methanol however this would not be recommended for two main reasons. Firstly, the capture of CO₂ from flue gases is both capital and energy intensive. The energy required to capture the CO₂ usually results in additional CO₂ emissions elsewhere in the flowsheet e.g. from the auxiliary boiler to raise the additional steam required. Therefore capture of CO₂ from the flue gas of a SMR/fired heater is generally viewed as being CO₂ emission neutral for a significant increase in Capex of the plant and JM would only recommend this technology for a debottlenecking revamp project. Secondly, the use of CO₂ in the methanol unit will result in a reduction of hydrogen available for the ammonia unit and so it will therefore result in a reduced ammonia make for the same Capex or an increased Capex for the same ammonia make.

Q15. What sort of flexibility between MeOH and NH₃ can one expect in operation, notwithstanding the flowsheet design basis.

A15. Expected flexibility during normal operation is 60-105% for the methanol unit and 45-105% for the ammonia unit. Increased flexibility to increase production above 105% can be added in at the design stage if required, but this additional flexibility will typically result in an increase in Capex.