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ECONOMICS OF CO-PRODUCTION OF METHANOL IN AMMONIA/UREA COMPLEX[1]

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SUMMARY

The paper explains the rationale for methanol co-production. It highlights the result of study carried out by Petronas Fertilizer to determine the optimum co-production capacity and process option. Finally, it shows the economics analysis result of methanol co-production in the ammonia/urea complex.

RESUME

Cet exposé décrit les raisons de la production associée de méthanol. Elle insiste sur les résultats d'une étude effectuée par Petronas Fertilizer pour déterminer la capacité optimum de production et le choix de procédé. Enfin, elle donne les résultats d'une analyse économique de la production associée de méthanol dans un complexe d'ammoniac/urée.

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Background

PETRONAS Fertilizer (Kedah) Sdn. Bhd (PFK) is a wholly owned subsidiary of PETRONAS, Malaysia's national oil company. The company was set up to build, operate and own Malaysia's second ammonia/urea project, the first being the ASEAN Bintulu Fertilizer Sdn. Bhd. plant in Sarawak.

The second ammonia/urea project consists of an integrated ammonia /urea/ methanol/ urea-formaldehyde complex located in Gurun, in the state of Kedah and a urea export terminal located 56 km away at Butterworth Wharf in Penang. The two sites are linked by a railway line.

The plant uses 45 million standard cubic feet of natural gas as feedstock. The name plate capacity of the plant is as follows:

- 1125 MTPD anhydrous ammonia
- 1800 MTPD granular urea
- 200 MTPD methanol
- 17 MTPD of UF-85 urea formaldehyde

Haldor Topsoe is the process licensor for ammonia, methanol and urea formaldehyde while urea production is based on Snamprogetti process. Hydro Agri is the licensor for the granulation process.

The main contractor is made up of a consortium of Mitsubishi Heavy Industries Ltd., Mitsubishi Corporation and Shapadu Energy and Engineering Services Sdn Bhd. The contract is a lump sum, turnkey EPCC contract (Engineering, Procurement, Construction and Commissioning) based on 34 months completion period.

About half of the granular urea produced will be marketed to the users domestically in Peninsular Malaysia. The remainder will be exported through Butterworth Wharf to the regional markets such as Vietnam, Thailand and India. Excess ammonia and methanol from the plant will be sold to domestic users in Peninsular Malaysia. Marketing will be carried out by MITCO, PETRONAS' marketing arm.

The plant is scheduled for commercial operation in 1st Quarter 1999.

Rationale for Methanol Co-Production

The decision to coproduce methanol was based on the following reasons:

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[1] *Economie de la co-production de méthanol dans un complexe ammoniac/urée*

(i) to provide feedstock for the production of formaldehyde which is required on site for granular urea production

(ii) to diversify from ammonia production in times of poor ammonia and urea market.
The coproduction technology allows easy control of the balance between methanol and ammonia, thereby giving the choice to produce product which gives the highest profit margin. To a certain extent, this helps reduce the impact of price cycles.

(iii) to provide an alternative source of methanol to users in the Northern Region of Peninsular Malaysia, which are currently being supplied by the methanol plant in Labuan. With local production of methanol, methanol pricing will be more attractive due to the freight advantage.

(iv) to obtain through the synergy with the ammonia plant an economy of scale normally reserved for much bigger plants.

A study was carried out by PFK to determine the optimum coproduction capacity and the process option. The market study for methanol was carried out jointly with MITCO.

<u>Result of Study Capacity</u>

Based on the result of the market study and technical inputs from the various methanol process licensors, it was decided to integrate a 200 MTPD (66600 MTPY) methanol plant with the ammonia/urea plant.

<u>Methanol Coproduction Process</u>

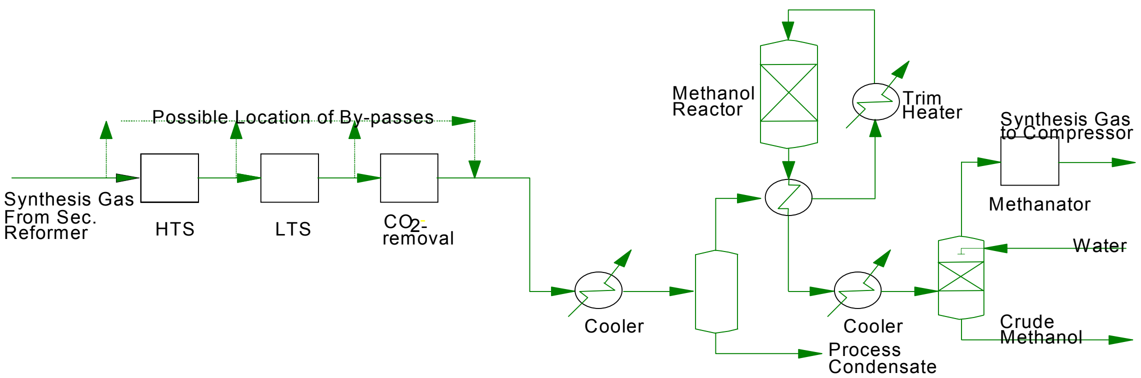
There are three options for methanol coproduction. Below is a description of each option and a comparison of the three process schemes in terms of energy consumption and investment.

1. <u>Low Pressure Coproduction</u>

As can be seen in Figure 1, the coproduction unit is inserted between the CO_2-removal unit and the methanator. Partial by-passes are arranged to provide the necessary CO and CO_2 for the methanol reaction. Since methanol reaction is disfavoured by low pressure, the limitation is on how much CO and CO_2 can be permitted to continue unconverted to the methanator. The methanol production potential is thus very low.

The coproduction unit, however is extremely simple with design pressure possibly sufficiently low to allow local manufacture of equipment.

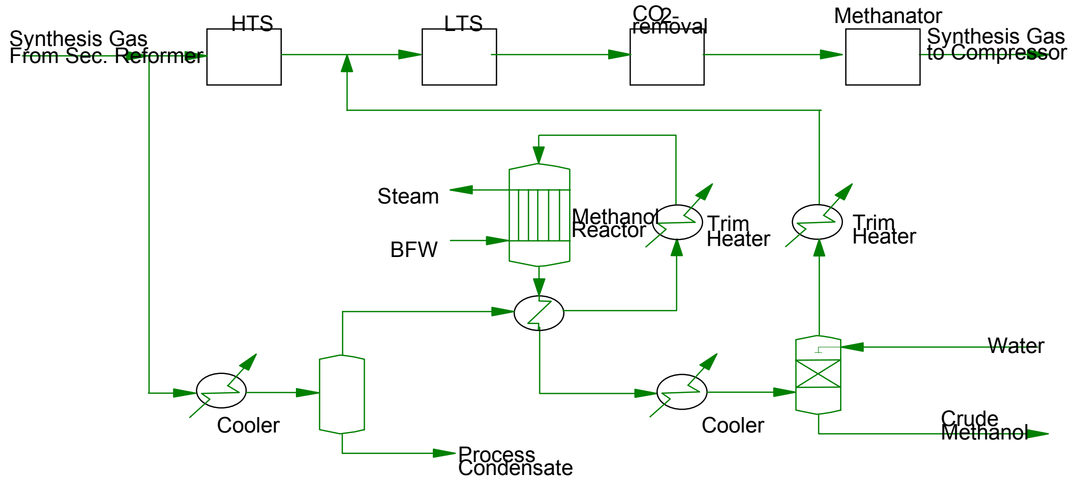
Fig 1 Low Pressure Methanolation



2. Side Stream at Front-end

Figure 2 shows a layout where a fraction of the synthesis gas is extracted upstream the high temperature shift, cooled and sent to a methanol converter and returned downstream the high temperature shift. The production of methanol is determined by the split ratio upstream the high temperature shift. At this location in the ammonia plant, the concentrations of CO and CO_2 are high, but the overall pressure is low. Consequently the conversion is less than desirable.

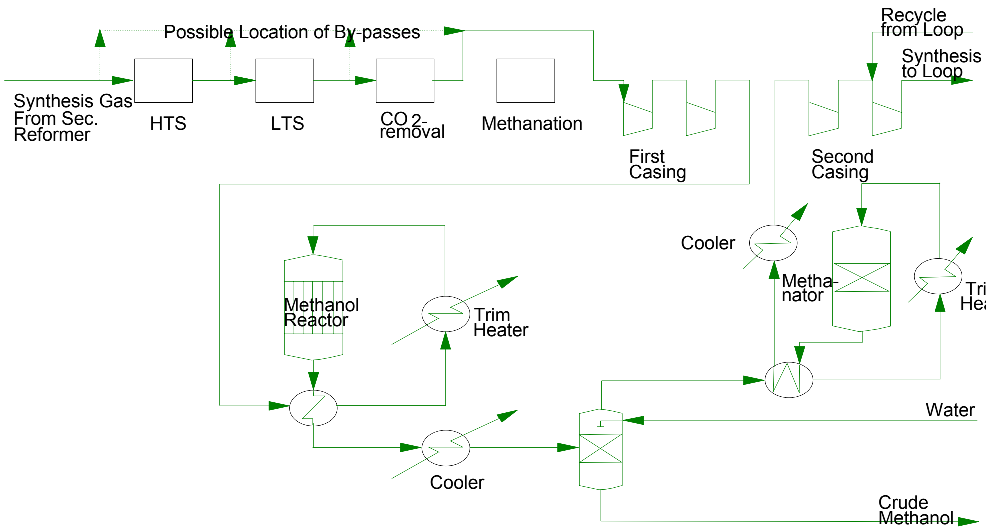
Fig 2 Side Stream Methanolation



3. High Pressure Co-production

Figure 3 shows the coproduction unit is located between the two casings of the synthesis gas compressor, i.e. at higher pressure than the previous scheme. It is possible to operate at high concentrations of CO and CO_2 giving a high production rate. The coproduction unit consists of a methanol synthesis reactor followed by a new high pressure methanator. In the front-end of the ammonia plant the low temperature shift, the CO_2 - removal, the existing methanator, and possibly the high temperature shift are by-passed, wholly or partly to leave sufficient amounts of CO and CO_2 in the synthesis gas for the desired methanol production.

Fig 3 High Pressure Methanolation



Key figures for comparison of the three process schemes are shown in Table 1 below where the co-production unit is installed in a 1,350 MTPD ammonia plant.

Table 1

COMPARISON OF KEY FIGURES OF THE THREE PROCESS SCHEMES

	LOW PRESSURE	SIDE STREAM	HIGH PRESSURE
Methanol production range, MTPD	up to 20	up to 200	up to 400
Relative energy consumption per MT product, % 1), 2)	+ 25	+ 5	- 5
Relative specific investment, index cost/MT 2), 3)	100	35	20

1) Relative energy consumption per MT of methanol compared to original energy consumption per MT of ammonia. Methanol purification is not included.
2) Indicated for unit of midrange capacity.
3) Cost is indexed relative to the cost of the low pressure co-production scheme

Co-production unit installed in a 1350 MTPD ammonia plant.

The High Pressure Co-production Process was proposed by the Process Licensor, Haldor Topsoe for PFK's plant, in particular because this was a new facility where the synthesis gas compressor would not have to be checked/modified, and the methanator would not have to be duplicated. The process has been demonstrated in an ammonia plant in the Middle East since the spring of 1993 and another unit went on stream in the US during May 1994.

Economic Analysis Result

An economic analysis on PFK's ammonia/urea plant with methanol coproduction was carried out and compared against the economics without methanol coproduction.

Table 2 shows an improved project economy of 9.8% (IRROI, real, after tax) for the integrated ammonia/urea/methanol/formaldehyde plant as against 8.6% for the ammonia/urea complex without methanol coproduction.

Table 2

ECONOMIC ANALYSIS

	AMMONIA/UREA PLANT (BASE)	AMMONIA/UREA WITH METHANOL COPRODUCTION
RESULT		
IRROI,REAL, AFTER TAX	8.6 %	9.8 %
KEY PARAMETERS		
1. INVESTMENT COST, INDEX	100	106
2. ANNUAL MANUFACTURING COST, INDEX	100	105

Conclusion

The partial conversion of ammonia capacity to methanol capacity offers several advantages in terms of improved economics, product diversification, operation flexibility and better marketing perspectives, in particular for new plants. More importantly for PFK is the onsite production of methanol for urea formaldehyde which is captively used in granular urea production.