Operating TIGAS Coal-Based Gasoline Synthesis Process

Research I Technology I Catalysts

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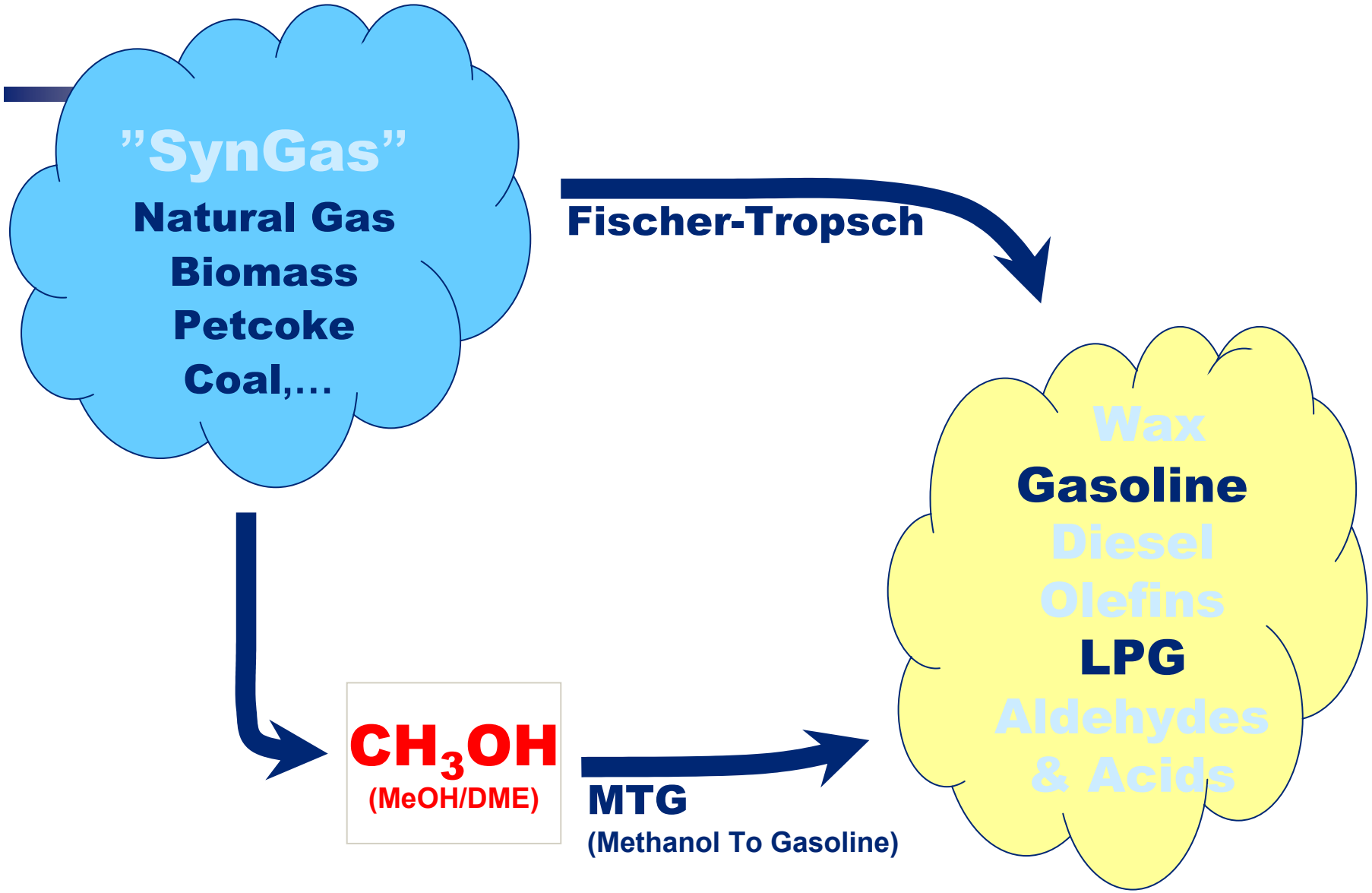

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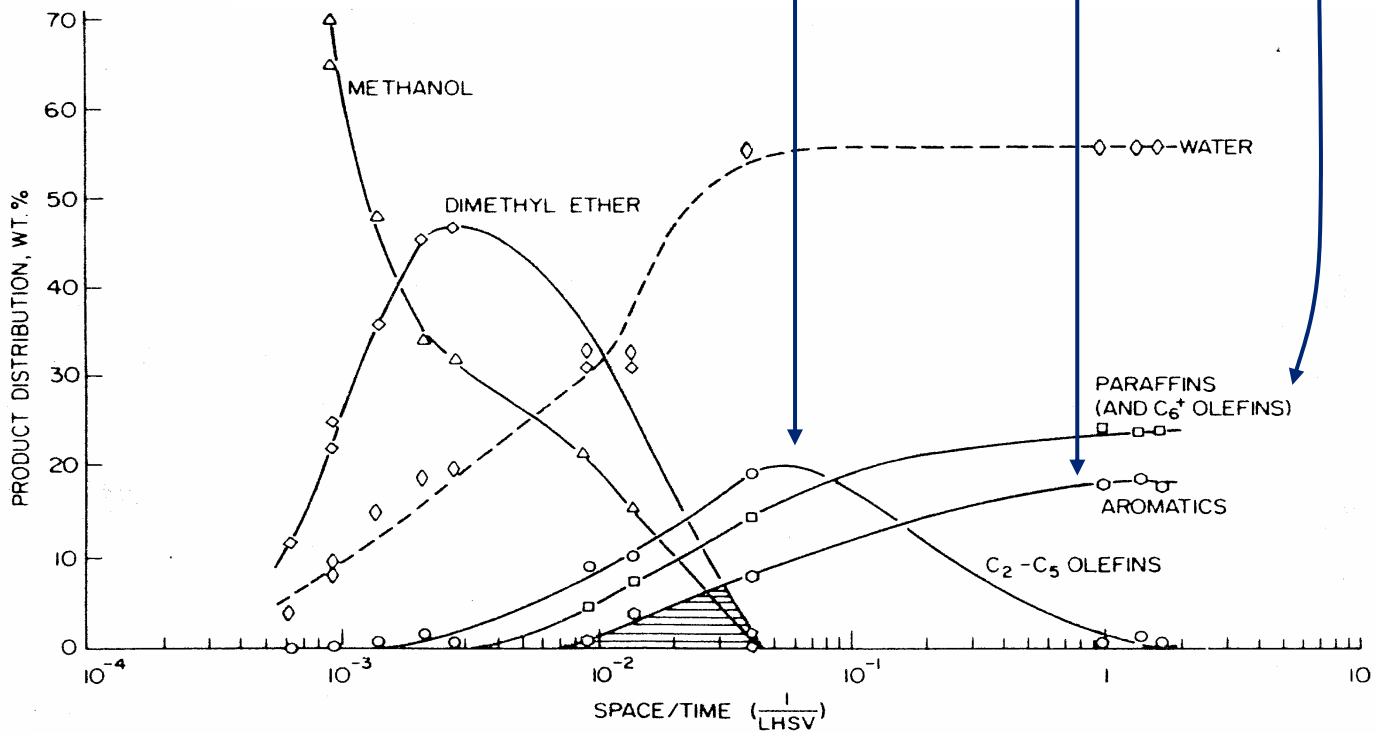
Zeolite (Acid) Catalyzed MTH

Methanol to Gasoline (MTG)

Catalyst: HZSM-5, T = 350-400°C, P ≈ 20 bar (Mobil 1976)

MTG Reaction Sequence

MeOH/DME → Olefins → Aromatics + Paraffins



C.D. Chang, *Catal.Rev.Sci.Eng.* **25** (1983) 1

Methanol to Gasoline

Mobil (MTG):

SynGas → MeOH ; MeOH → DME → Gasoline

MTG (Methanol To Gasoline)

15,000 bbl/d Industrial Plant, Motonui, NZ

Topsoe (TIGAS):

SynGas → MeOH/DME → Gasoline

TIGAS (Topsoe Integrated GAsoline Synthesis)

> 20,000 hrs. Pilot Plant Operation

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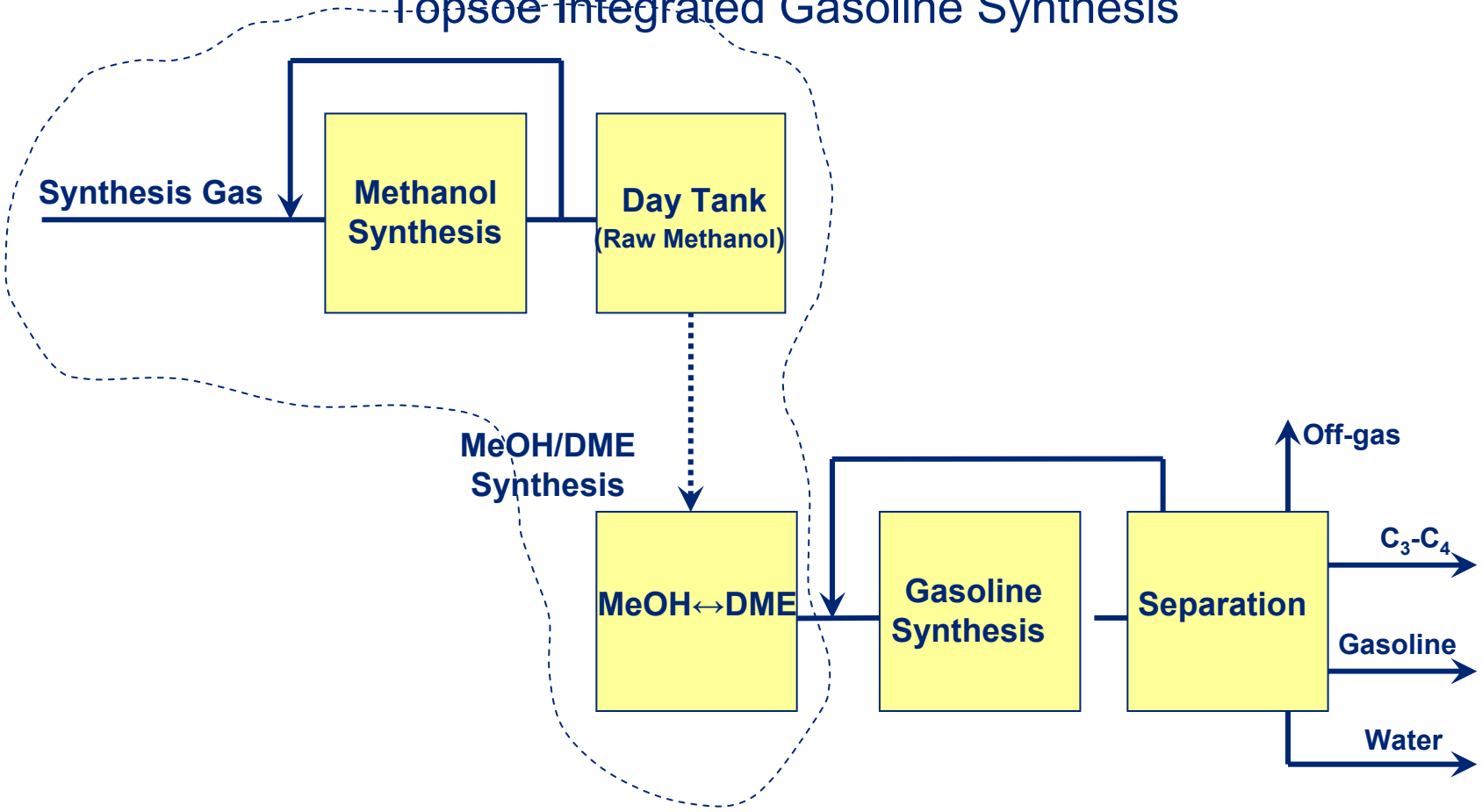
MTG Methanol-to-Gasoline

TIGAS

Topsoe Integrated Gasoline Synthesis



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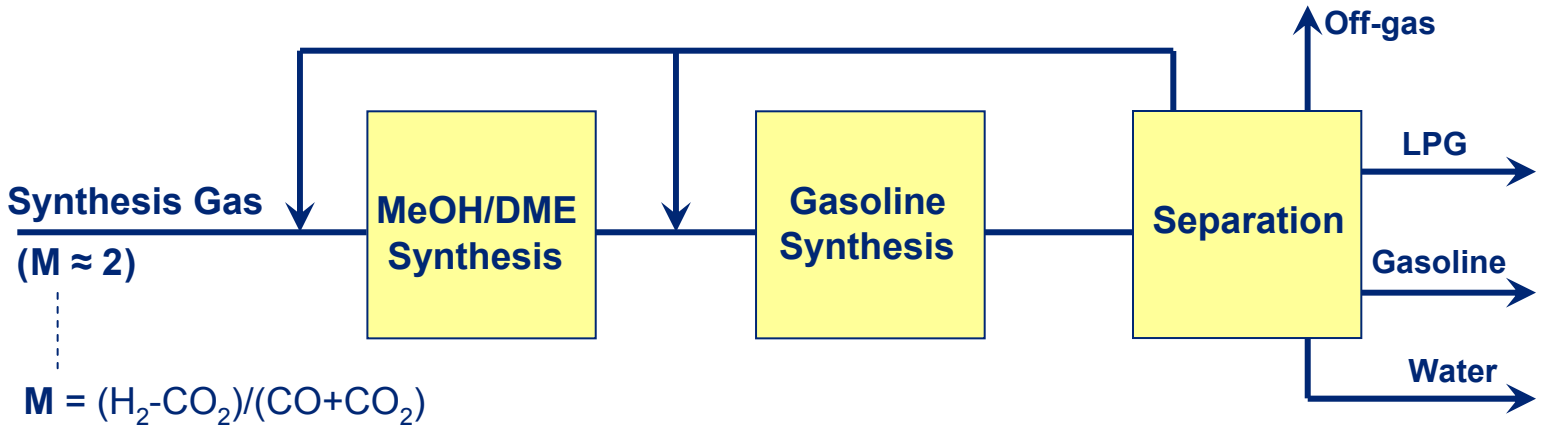
TIGAS (Topsoe Integrated GAsoline Synthesis)



- Simple process layout
- Low recycle
- No methanol condensation / re-evaporation
- Moderate pressure

Topp-Jørgensen, *Stud.Surf.Sci.Catal.* ***36*** *(1988) 293*

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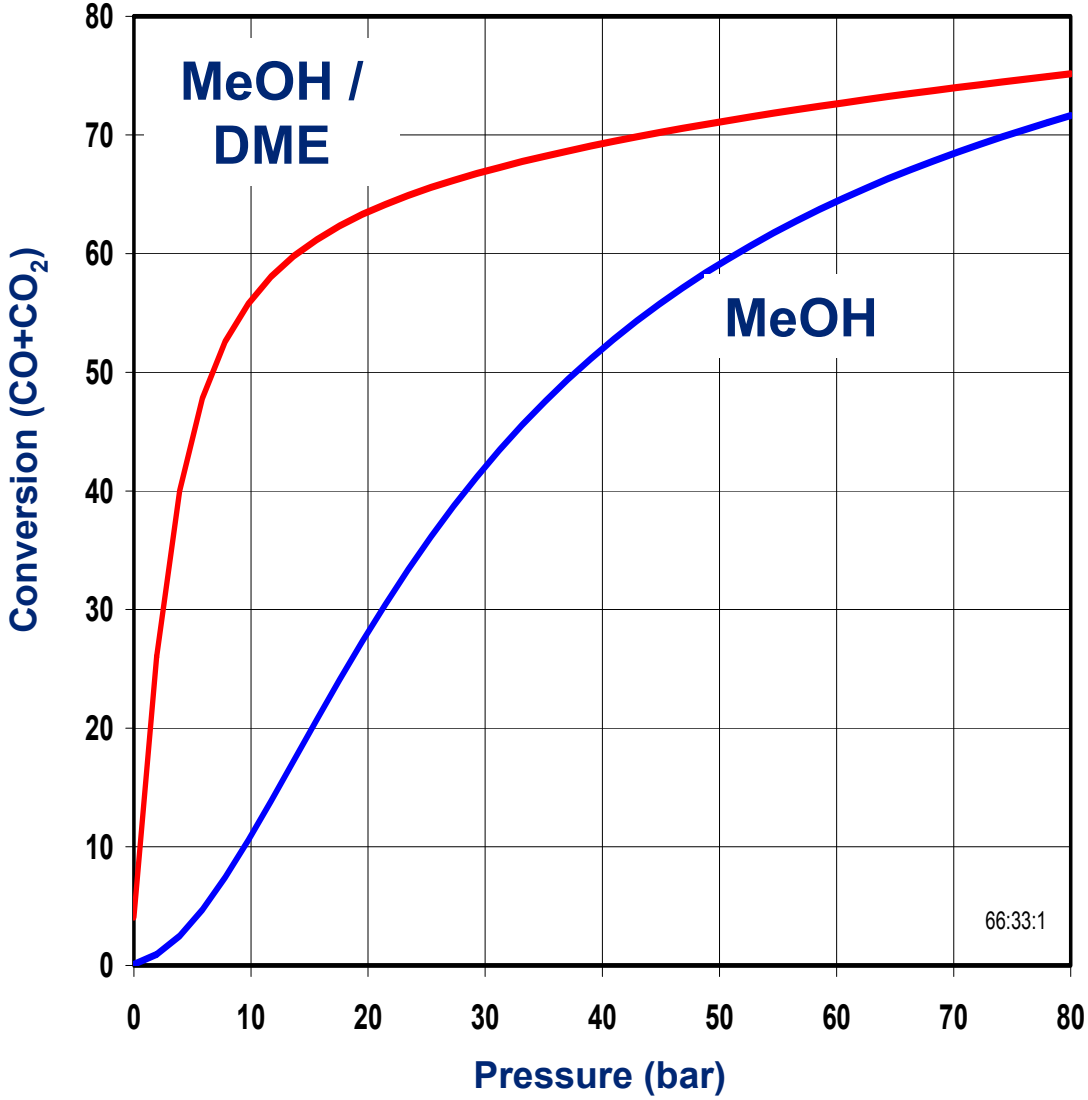
Syngas Eq. Conversion vs. Pressure



- **T = 240°C**
- **Feed Gas** (mol%):

H_2 = 66
CO = 33
CO_2 = 1

$CO + 2H_2 = MeOH$

$2MeOH \rightarrow DME + H_2O$

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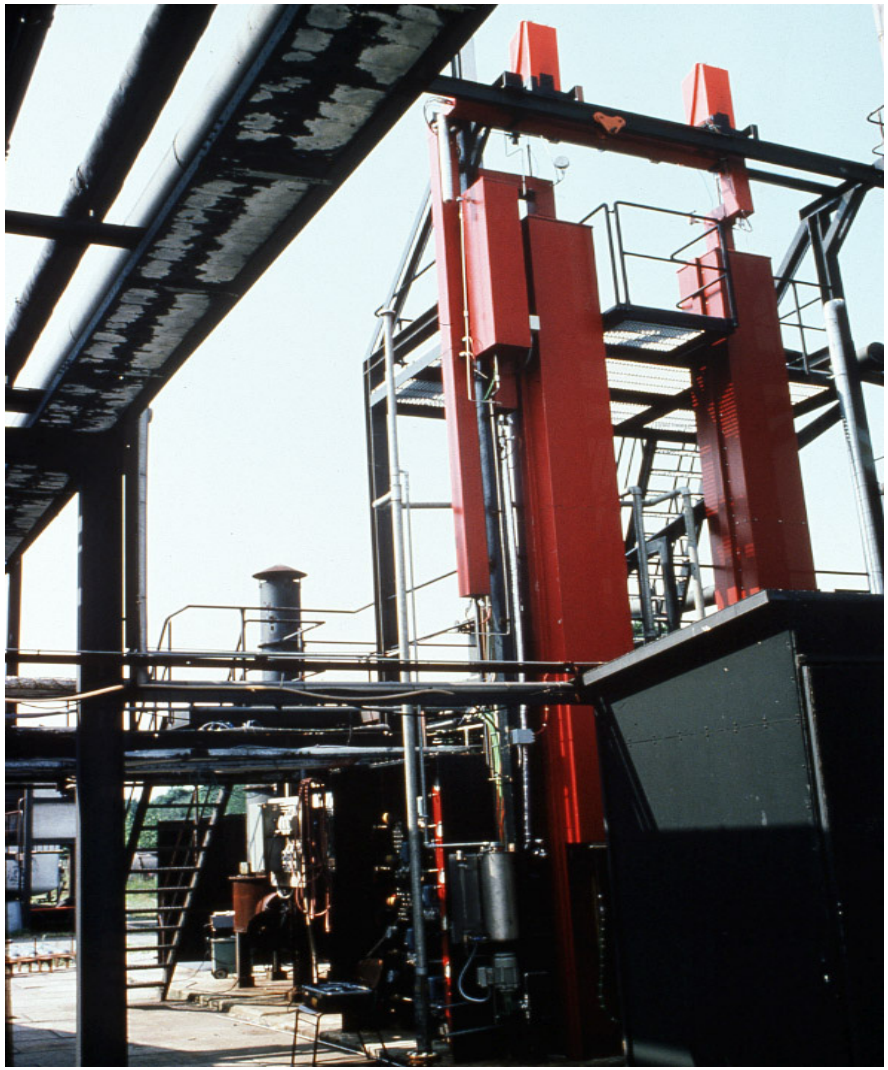
Kg/h Gasoline Pilot Plant – Denmark



Backup for process layout studies

Single-tube MeOH/DME reactor (BWR)

Adiabatic gasoline reactor

20000_{+} runhours

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TIGAS Demonstration Plant

1 T (8 bbl)/d 7000_+ hours Houston,TX

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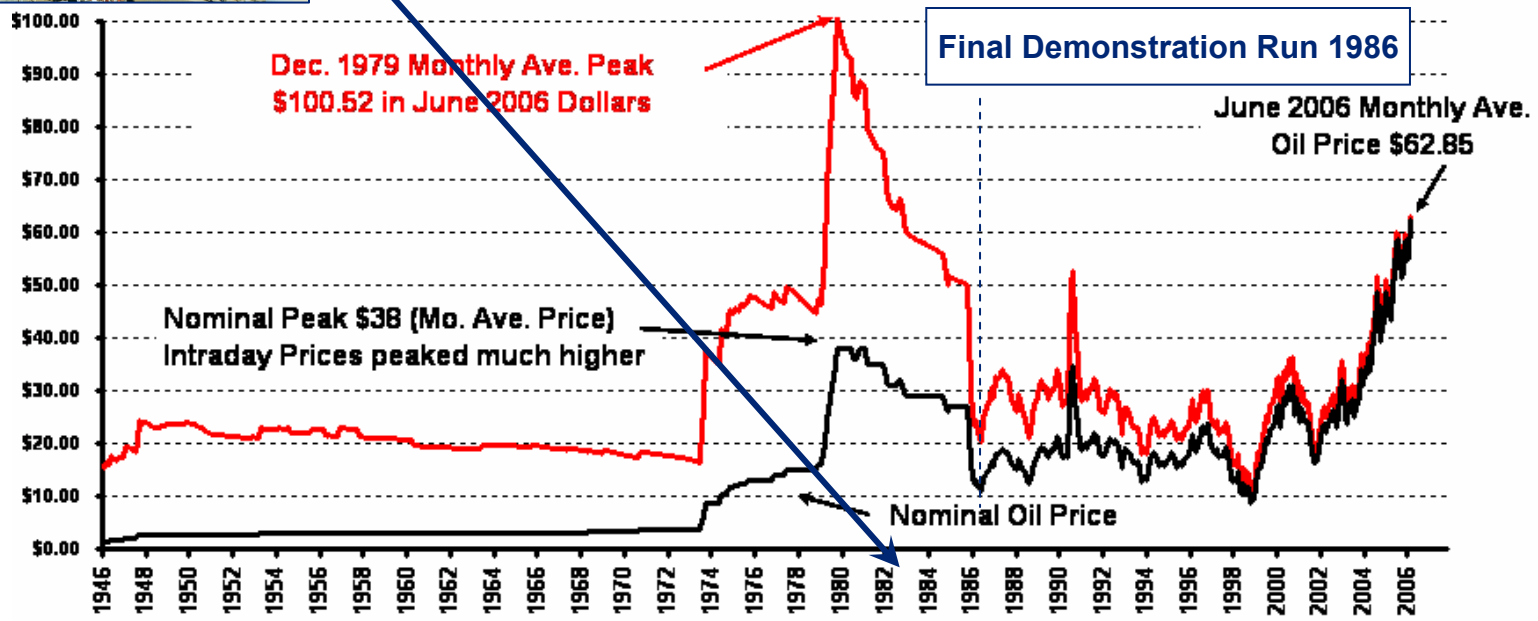
Gasoline Product Characteristics

	8 bbl/d Demonstration Run
C5+	76 wt-%
RON	89
MON	83
½(RON+MON)	86
Gasoline Components	PNA (= olefin-free)
Light Ends	Paraffins (LPG)

Gasoline - Economic perspective

Inflation Adjusted Monthly CRUDE OIL PRICES (1946- Present)
In May 2006 Dollars
© www.InflationData.com
Updated 7/18/06



Nominal Monthly Ave. Oil Price
Inflation Adjusted Monthly Average Oil Price

Source of Data:
Illinois Basin Crude Prices- www.ioga.com/Special/crudeoil_Hist.htm
CPI-U Inflation index- www.bls.gov

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The Gasification Based Scenario – (H_2/CO < 1)

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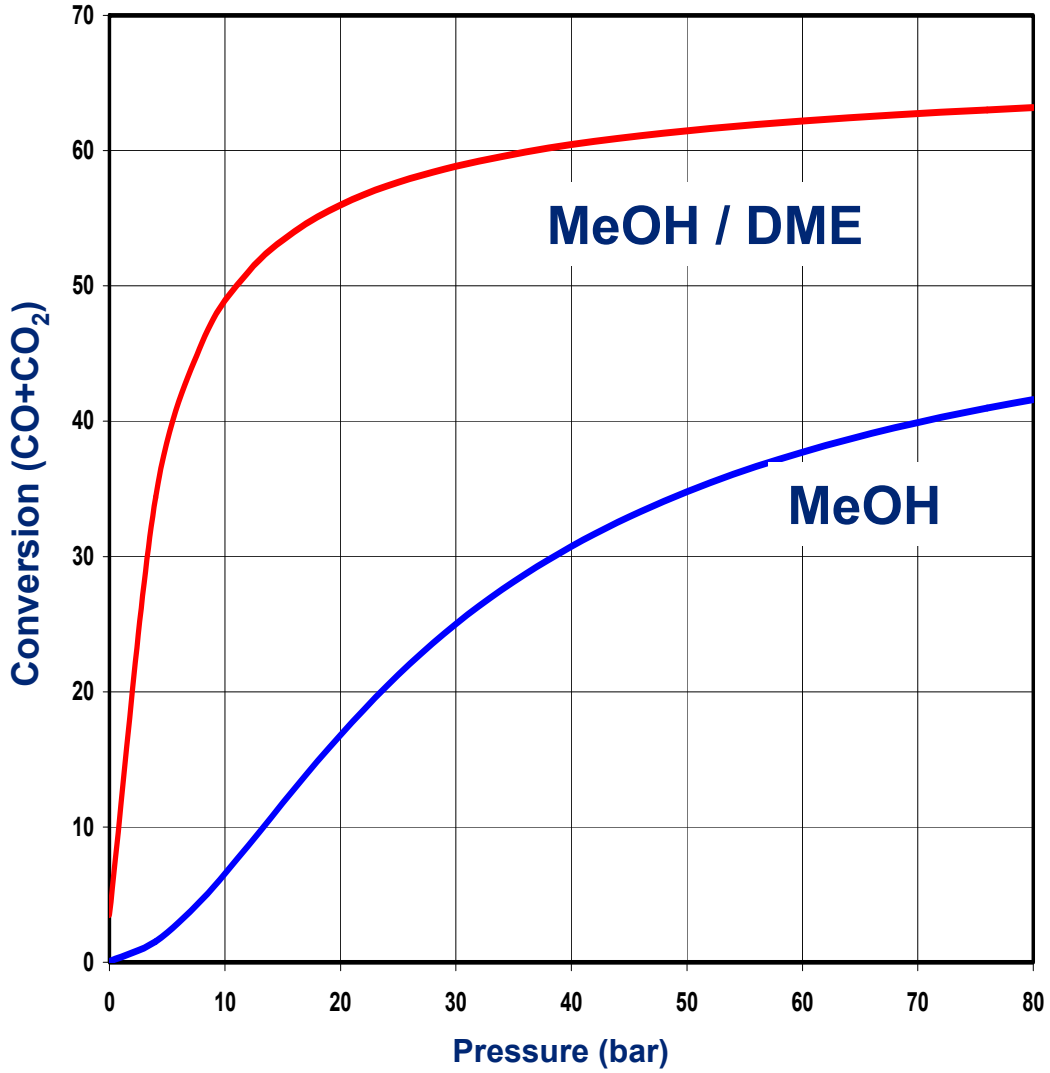
Eq. Conv. vs. Pressure at low H_2/CO



- **T = 240°C**
- **Feed Gas H_2 = 51**
  CO = 48
  CO_2 = 1

High *per pass* conversion enables recycle ratio to be drastically reduced - even at moderate pressure

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MeOH/DME Synthesis (at Low H_2/CO)

$$2H_2 + CO = MeOH$$

$$2MeOH = DME + H_2O$$

$$CO + H_2O = CO_2 + H_2$$

$$3H_2 + 3CO = CH_3OCH_3 + CO_2$$

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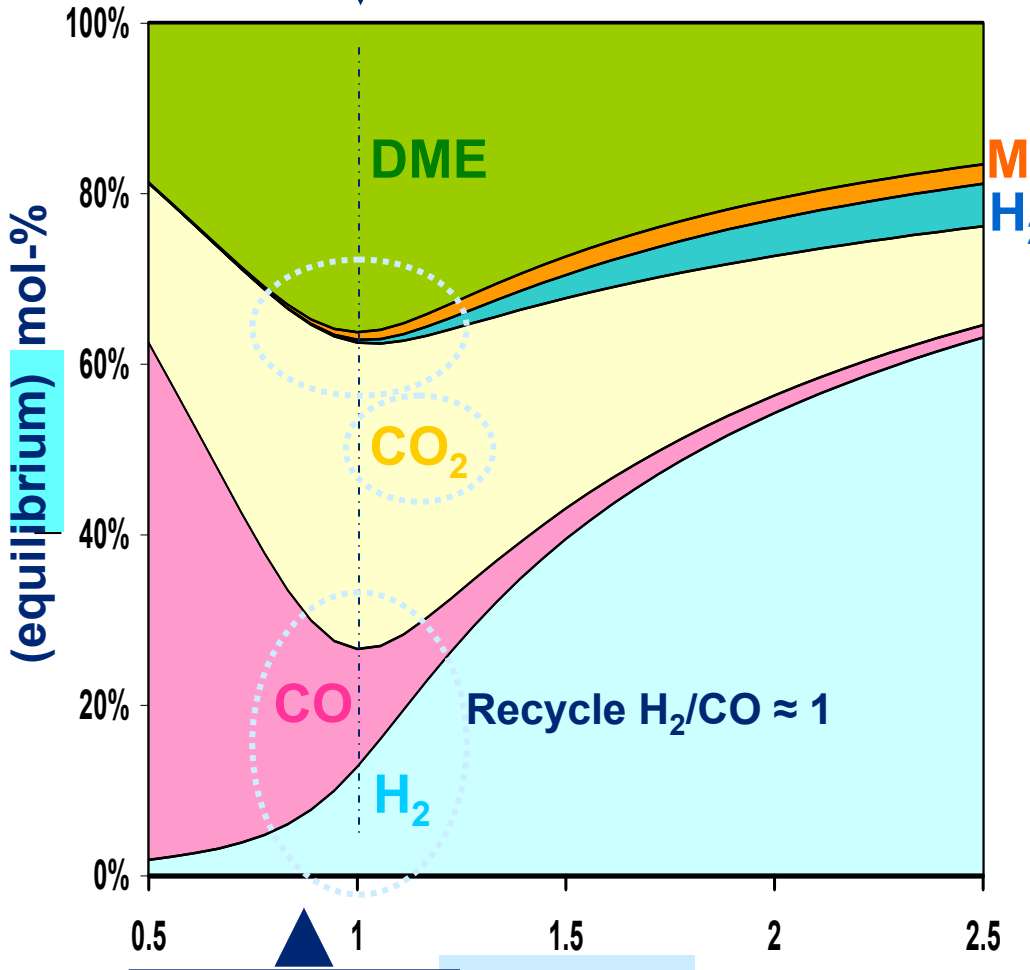
$H_2/CO = 1$ is *the* optimum for DME



High conversion makes CO_2-removal inside synthesis loop feasible

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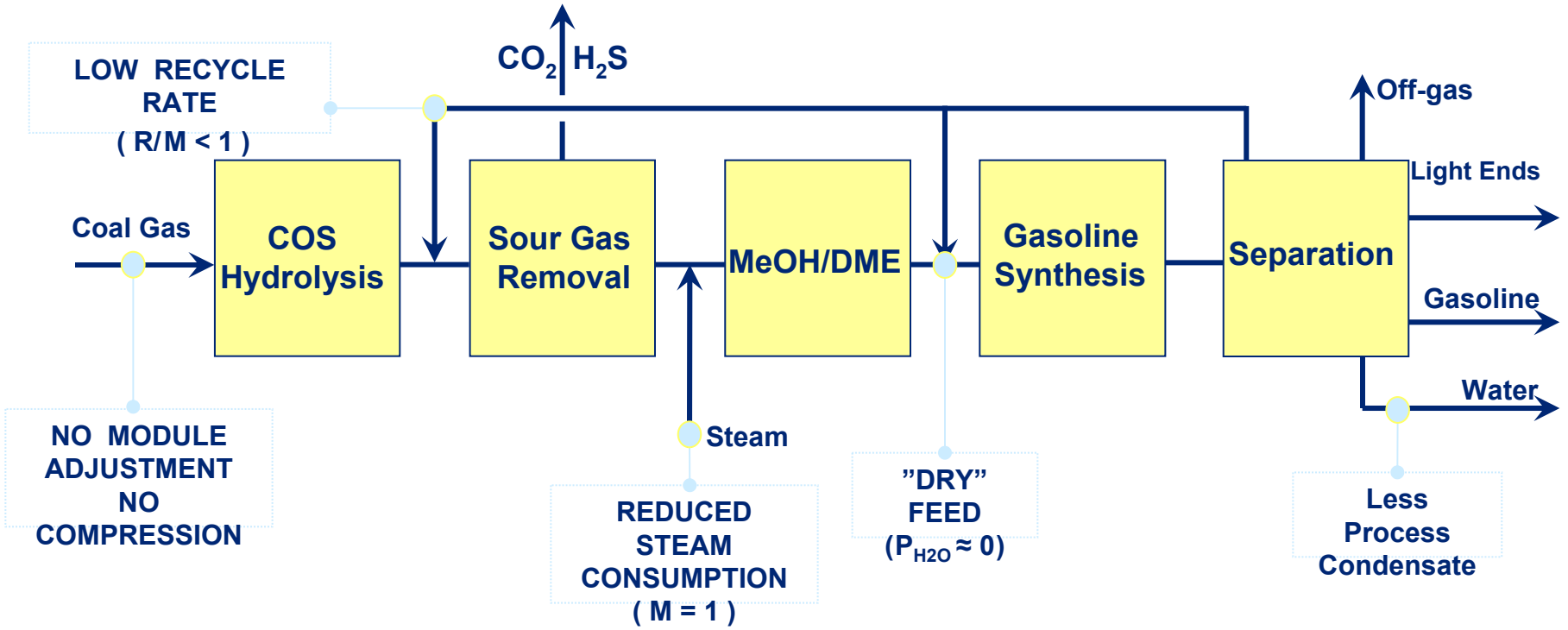
Coal Gas to Gasoline



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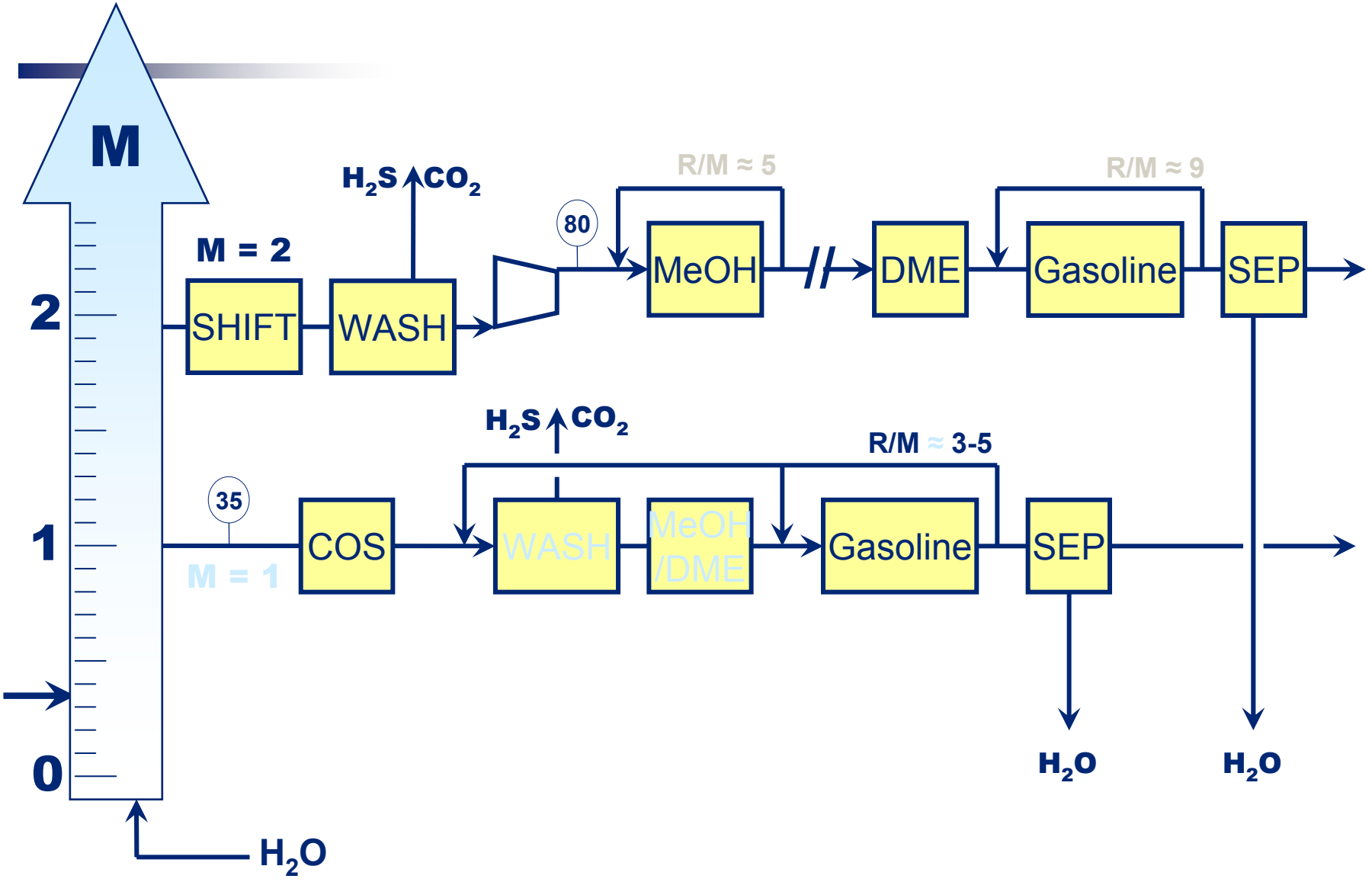
The Module Barrier Shortcut



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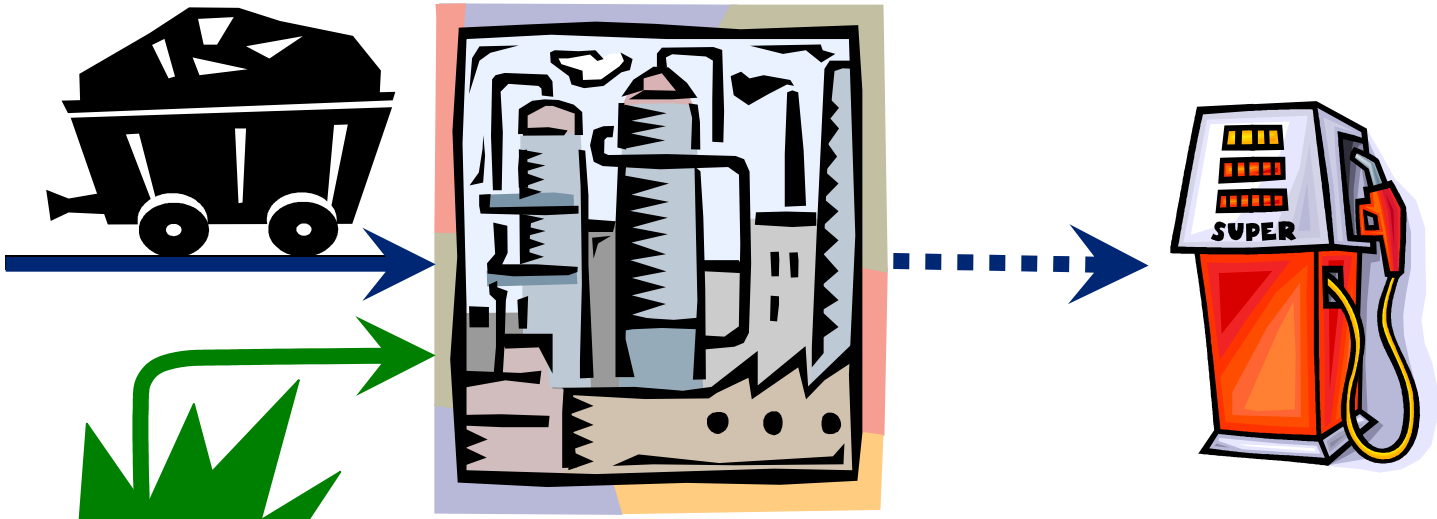
1 T (MAF)



Ethers
Olefins
Alcohols
Bio-Fuels

300 kg*

* 300 kg (108 Gal) C_{5+}
+ 60 kg LPG

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Coal Gas to Gasoline Drivers

- High and sustaining oil prices
- Two-digit growth rates in China/India
- Growing demand for transportation fuels
- Growing awareness of degree of self-supply
- Vast coal reserves in North America / China / India
- Gasification on the move

…all make a good reason to revisit syngas-to-gasoline technologies