Thermodynamic analysis of glycerol conversion to synthesis gas

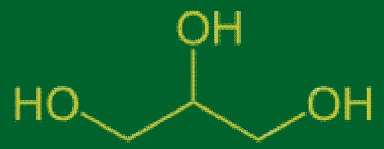
Kamila Zeńczak, Paulina Kozłowska*

Faculty of Chemical Engineering and Technology
Tadeusz Kosciuszko Cracow University of Technology

Institute of Organic Chemistry and Technology

Why glycerol? Why synthesis gas?

Glycerol



- ❑ unique structure and properties
- ❑ bioavailability
- ❑ renewability

- ❑ **biodiesel production**

(main side-product: ~ 10 wt. %)

- ❑ numerous possibilities for its conversion to:
  - ▪ acrolein and acetol
  - ▪ diols (1,2- and 1,3-propanediol, etylene glycol)
  - ▪ glycerol carbonate
  - ▪ synthesis gas

Synthesis gas

$CO + H_2$

- ❖ many applications in chemical synthesis
  - • methanol production
  - • hydrogen production
  - • oxosynthesis
  - • Fischer-Tropsch process

Thermodynamic analysis of glycerol conversion to synthesis gas

Main reagents of glycerol conversion (with or without CO_2):
Glycerol, carbon monoxide, carbon dioxide, hydrogen, water, methane

Table 1. Selected stoichiometric models.

1st model	$C_3H_8O_3 + 3H_2O = 3CO_2 + 7H_2$ (1a)	Glycerol conversion with steam *(steam reforming)*
	$CO_2 + H_2 = CO + H_2O$ (1b)	
	$CO_2 + 4H_2 = CH_4 + 2H_2O$ (1c)	
2nd model	$C_3H_8O_3 + CO_2 = 4CO + 3H_2 + H_2O$ (2a)	Glycerol conversion with carbon dioxide *(dry reforming)*
	$CO_2 + H_2 = CO + H_2O$ (2b)	
	$CO + 3H_2 = CH_4 + H_2O$ (2c)	
3rd model	$C_3H_8O_3 = 3CO + 4H_2$ (3a)	Glycerol conversion without any co-substrate
	$CO + 3H_2 = CH_4 + H_2O$ (3b)	
	$CO + H_2O = CO_2 + H_2$ (3c)	

Conclusions

- **It was found that the contribution of synthesis gas in the equilibrium mixture increases with the increase temperature.**
- **In the steam reforming of glycerol synthesis gas rich with hydrogen is produced, while in the dry reforming the carbon monoxide predominates in the equilibrium mixture.**

Acknowledgements

Special acknowledgements are due to Mr. Dr. Piotr Michorczyk for his interest in our studies and fruitful collaboration.

The conference was supported by the European Union through the European Social Fund within „Cracow University of Technology development program - top quality teaching for the prospective Polish engineers; University of the 21st century" project (contract no.UDA-POKL.04.01.01-00-029/10-00)