Praca dyplomowa inżynierska

Measurements of hydrogen solubility in Nitrobenzene/Aniline mixtures

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Introduction

The subject of this work is the measurement of hydrogen solubility in nitrobenzene-aniline mixtures under different process conditions. The reduction of nitrobenzene to aniline is a highly exothermic heterogenic reaction. The heat created in this reaction can be reused to generate process steam. This way energy from an outside source can be spared. The amount of hydrogen dissolving in the liquid mixture directly affects and limits the process.

Purpose and scope of work

The purpose of this work are measurements of hydrogen solubility in various nitrobenzene-aniline mixtures under the influence of different temperatures and stirrer rotation speeds. The experimental part was conducted in the Institute for Micro Process Engineering in Karlsruhe Institute of Technology in July and August 2015.
The scope of this work consists of:
- Experimental work
- Analysis of experimental data gained
- Further interpretation of the collected data: calculation of L factor, formulation of correlation for Henry's constant for pure nitrobenzene and pure aniline $logH = f(T)$, correlation for Henry's constant in relation to aniline's concentration $log(H_{AN}/H) = f(c_{AN})$

Experimental set-up

The experiments were conducted in an autoclave reactor with a stirrer propelled by an electric motor. A pressure gauge and a thermocouple Cr-Ni were built into the autoclave reactor. The autoclave reactor was electrically heated and secured by a thermal tape from cooling down.

Results

L factor was defined as the amount of solved hydrogen in the volume of liquid contained in the used reactor per unit of pressure. Fig. 1 and Fig.2 show the relations between L factor in used mixtures and temperature.
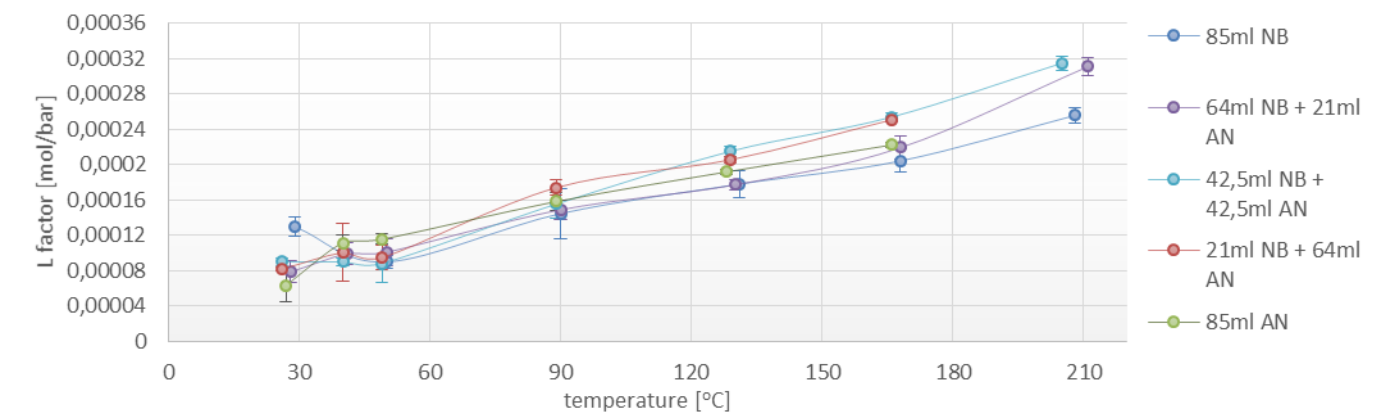

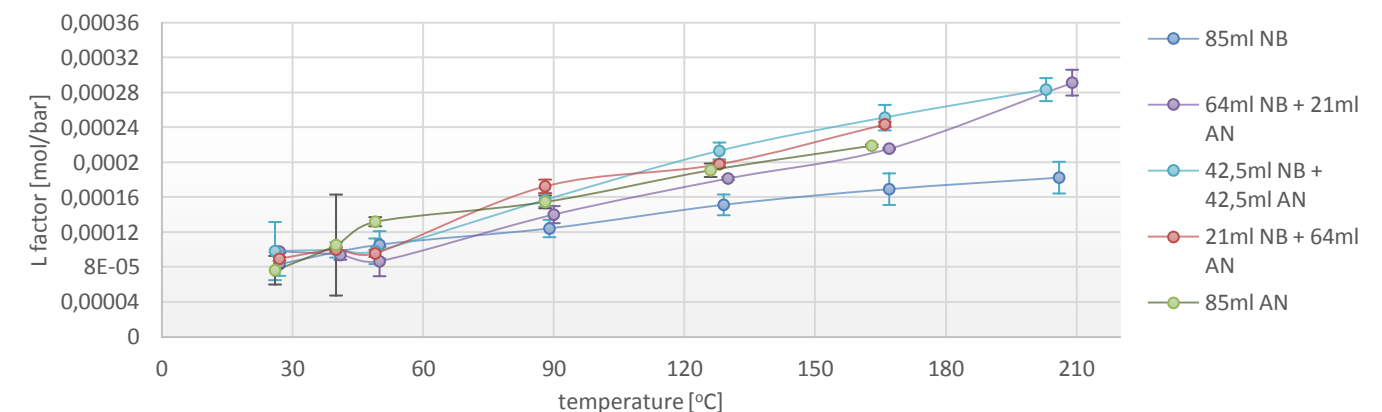Fig.1. Average L factor of hydrogen in nitrobenzene-aniline mixtures at 1200 rpm

Fig.2. Average L factor of hydrogen in nitrobenzene-aniline mixtures at 1600 rpm

Conclusion

It was found that hydrogen's L factor in nitrobenzene-aniline mixtures rises with the rise of temperature for the process parameters of temperature between $30°C$ and $210°C$ and for pressures between $20\,bar$ and $30\,bar$. Although such a behaviour is unusual for gases dissolving in liquids, it was proven with adequate literature that hydrogen is an exception.

Based on the results of experiments, Henry's constants were calculated. Then a relation between Henry's constant and temperature in form of $logH = f(T)$ (a linear equation) was proposed for pure nitrobenzene and aniline separately.

Finally, a correlation between Henry's constant and aniline's concentration $log(H_{AN}/H) = f(c_{AN})$ for each temperature was calculated. It can be used to estimate Henry's constant for any experiment within the process parameters used in this work.