Praca dyplomowa inżynierska

Investigations on the emulsification in a micro device dependent on interfacial tension and viscosity

Autor: Natalia Tomkowska

Nr albumu: 234960

Promotor: dr inż. Paweł Sobieszuk
Opiekunowie pomocniczy: Dipl.Chem. Manfred Kraut,
Dipl. –Ing. Andreas Hensel
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Introduction

Microreaction technology covers the chemical reactions carried out in micro structured reactors. Reducing the characteristic lengths of the devices into the range of mili- or micrometers gives us the intensification of heat and mass transfer. With the reduction of linear dimensions we can achieve also higher gradients of temperature, density, concentration or pressure. Efficiency of the process can be obtained during very short duration of the experiment (milliseconds). The surface to volume ratios can rise in a micro-structured apparatus to several thousand m^2/m^3 and it can be efficiently used in heterogeneous systems and for heat transfer.

Task Description

The aim of this study was to examine the process of production of emulsion using microengineered devices. All the experiments were performed at Institute for Micro Process Technology (IMVT) in Karlsruhe Institute of Technology, Karlsruhe, Germany.
Scope of this work includes:

- Characterization of emulsions and types of their production
- Discussion about the problem of viscosity and stability of emulsions
- Presentation of microengineered devices for production of emulsions
- Production of water-in-oil emulsion using V-type Micromixer

V-type Micromixer

Microstructured V-type Mixer was manufactured at IMVT. Channels are cut straightforwardly in a metal foil, clipped and stacked together. The dimensions are 0,2x0,2 mm. The mechanism is using the parallel lamination which increases the interfacial area and decreases the striation thickness by splitting the inlet streams into sub-streams. The fluid exits micro channel systems with an angle of 45^o to the mixing chamber and 90^o to each other, this causes the relatively small zone of enhanced contact .

Design of the Process

Schematic representation of the process of production of oil-in-water emulsion is shown in Fig.1:

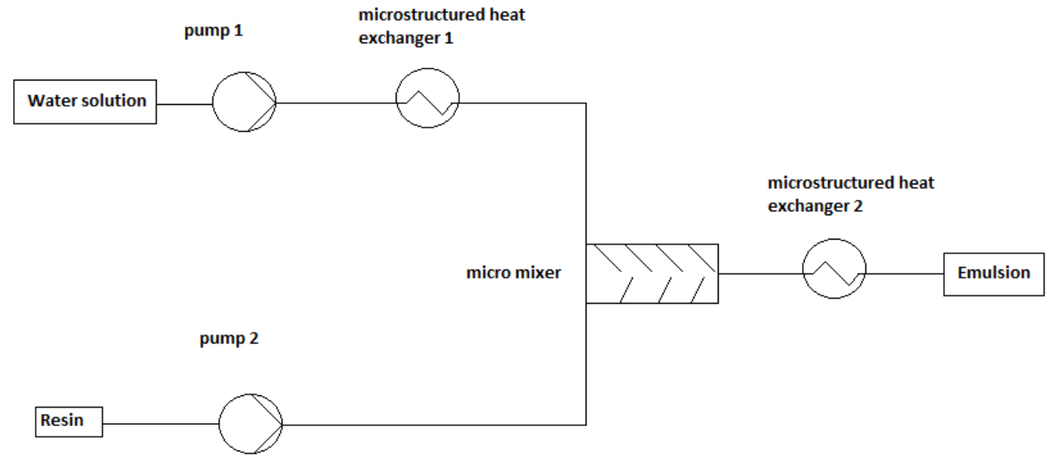

Fig.1. Scheme of continuous emulsification experimental set-up

The setup is shown in the Fig. 1. Water solution is pumped from the big tank with earlier mixed water solution (water, ammonia, emulsifier) and then heated to 80^oC in micro heat exchanger manufactured in the Institute for Micro Process Engineering (IMVT). Preheated in the thermostat resin is pumped from the other side. Mixer is made from stainless steel, manufactured at IMVT. Emulsion after being produced in a micromixer can be cooled down in the micro heat exchanger. This step is optional. Finally product is collected to the plastic sample bottles.

Research was focused on the viscosity measurement and the stability as a function of time and temperature of the emulsions. Rheological properties and the droplet size of the emulsions were also specified.

Conclusions

What can be concluded is that with the increase of the pressure loss we obtain higher flow rate and smaller diameters of particles. Emulsions have stable droplet size four weeks after production, while being stored in the fridge. It can be also stated that temperature has no influence on the stability of pH of the emulsion. Emulsions which have been produced in presented thesis are Newtonian fluids. It was unable to find any relation between viscosity and temperature for these emulsions. This dependency needs to be taken under further review.