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IMPACT OF SBT IMPELLER SPEED ON COPPER SORPTION ON ZEOLITE

UTJECAJ BRZINE VRTNJE SBT MIJEŠALA NA SORPCIJU BAKRA NA ZEOLITU

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Introduction

The sorption of copper ions on zeolite NaX is a heterogeneous process, and as such dependent on hydrodynamics in a batch reactor. Therefore, this work aimed to study the effect of mixing speed (different N/N_{JS} ratio values, i.e. different impeller speed and minimum impeller speed for complete suspension ratio values) on the kinetics and power consumption of the process examined.

Experimental

The kinetic experiments were conducted in a baffled glass batch reactor of nonstandard configuration, Fig. 1, at minimum impeller speed for complete suspension, N_{JS}, and at the impeller speeds corresponding to 70%, 90% and 120% of N_{JS} value. The suspension, 10.50 g of zeolite NaX size of particles in the range from 50 to 63 µm and 2.1 dm3 of copper(II) ion solution, was mixed using four straight blade turbine impeller, SBT (Fig.1) at 27°C. The Blanchard model [1], Mixed surface reaction and diffusion-controlled sorption kinetic model [2] and Webber-Morris model [3] were used to analyze the obtained experimental kinetic data to examine the controlling mechanism of the sorption process.
At different impeller speeds transient multiphase computational fluid dynamics model was developed using commercial software ANSYS Fluent v17.2.

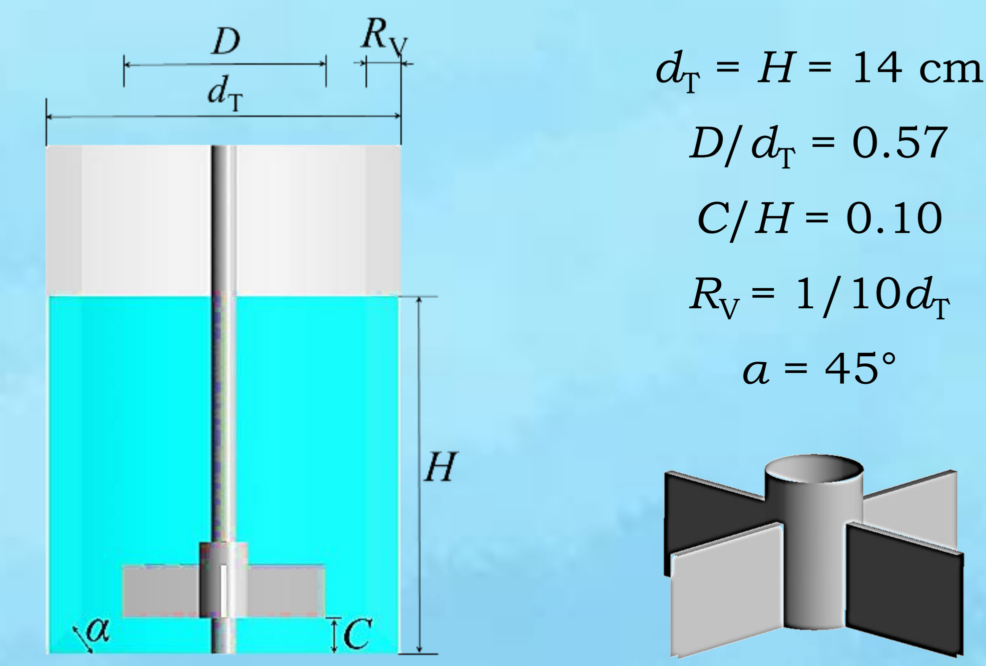

Figure 1. Geometrical arrangement of baffled batch reactor

Results

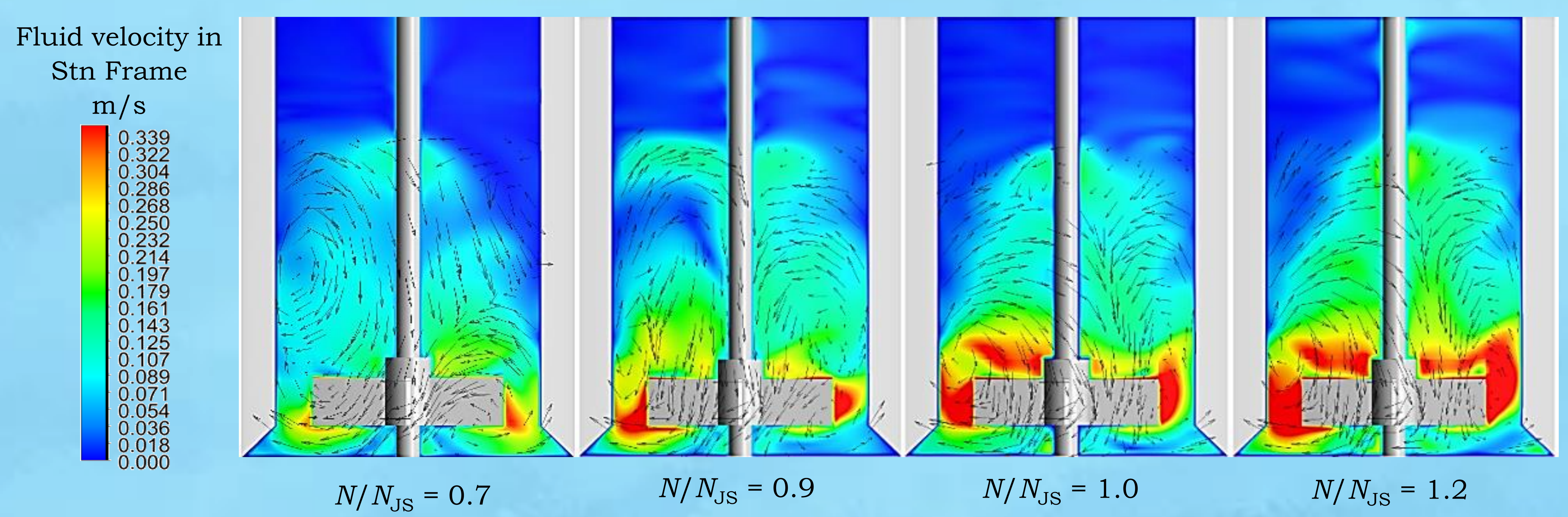

Figure 2. Velocities in stationary frame contours and vector plots

Table 1. Model parameters and statistical indicators of agreement of experimental data with models used

	Experimental data			Blanchard model			Mixed surface reaction and diffusion controlled adsorption kinetic model					Weber-Morris model		
N/N_{JS}	N_{JS} (rpm)	$q_{e,exp}$ (mmol/g)	$u_{e\ exp}$	q_e (mmol/g)	k (g/mmol min)	RMSE	q_e (mmol/g)	k (L/mmol min)	τ (min)	u_e	RMSE	k_d (mmol/g min$^{1/2}$)	I (mmol/g)	RMSE
0.7	92	1.074	0.963	1.075	4.814	$12 \cdot 10^{-3}$	1.076	0.834	$1.2 \cdot 10^{-3}$	0.996	$13 \cdot 10^{-3}$	0.075	0.671	0.272
0.9	119	1.094	0.966	1.096	5.386	$7.8 \cdot 10^{-3}$	1.083	0.872	$0.7 \cdot 10^{-3}$	0.932	$6.4 \cdot 10^{-3}$	0.076	0.691	0.278
1.0	132	1.080	0.948	1.083	5.982	$8.2 \cdot 10^{-3}$	1.075	0.893	$1.0 \cdot 10^{-3}$	0.913	$3.7 \cdot 10^{-3}$	0.074	0.694	0.279
1.2	158	1.093	0.971	1.907	7.670	$4.0 \cdot 10^{-3}$	1.090	1.233	$1.4 \cdot 10^{-3}$	0.960	$2.6 \cdot 10^{-3}$	0.073	0.715	0.286

Conclusion

Blanchard's model proved to be the best for describing the copper(II) ions sorption process on NaX zeolite under the given operating conditions.
The RMSE values calculated for the Blanchard model confirm that the Blanchard model is an acceptable kinetic model for describing the sorption kinetics of copper(II) ion on NaX zeolite under given reaction conditions. Calculated values of the Mixed model τ parameter almost equal to zero confirm that copper(II) ion sorption on NaX zeolite for the conditions investigated takes place in the kinetic domain.

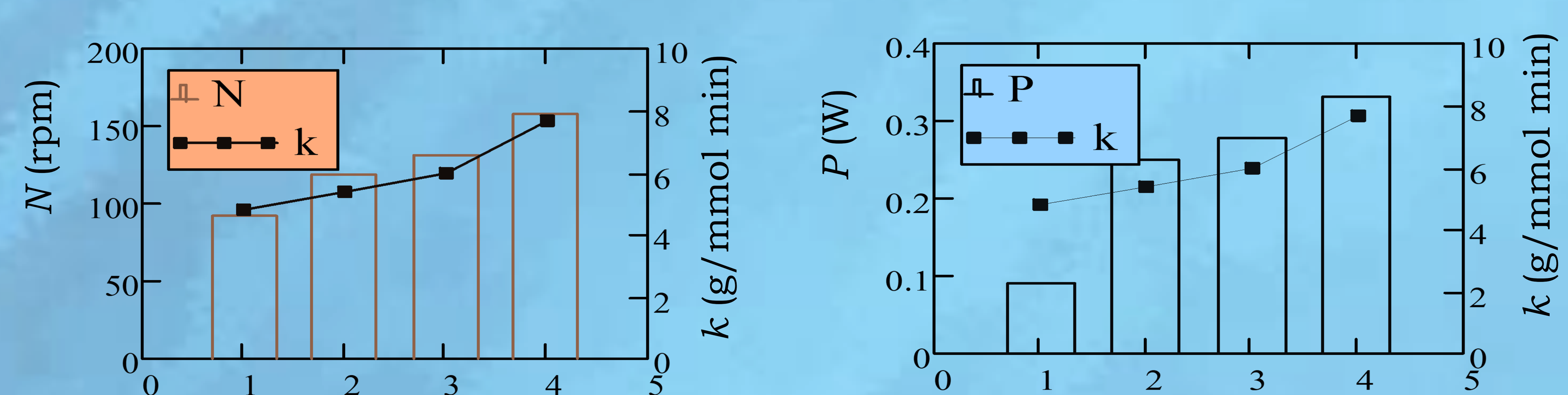

Figure 3. Reaction rate constant - impeller speed / reaction rate constant – power consumption relationship (1–N/N_{JS}=0.7, 2–N/N_{JS}=0.9 3–N/N_{JS}=1.0, 4–N/N_{JS}=1.2

Literature

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2. M. Haerifar, S. Azizian, J. Phys. Chem. C 117 (2013) 8310–8317.
3. W.J.Weber, J.C. Morris, Journal of the Sanitary Engineering Division, 89 (1963) 31-39.