INFLUENCE OF FLOW RATE OF LINEAR ALKYLBENZENE IN FILM SULFONATION REACTOR ON CONCENTRATION OF TARGET PRODUCT AND TETRALINES AND SULFONES CONCENTRATION

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RESEARCH OBJECT

Linear alkilbenzenesulphonated (LABS) represent chemicals with a saturated hydrocarbonic chain from 10–13 atoms of carbon connected with one or sulfonate groups. These substances are one of the widespread anions used for production of synthetic detergents. Raw materials for production of LABS is an alkilbenzenesulphuric acid (ASA) which is produced as a result of course of the following stages:

1) dehydrogenation of alkanes with receiving an alkenes on Pt-catalyst;
2) benzene alkylation by olefins with production linear alkylbenzene (LAB).
3) sulphonation of LAB in a film reactor.

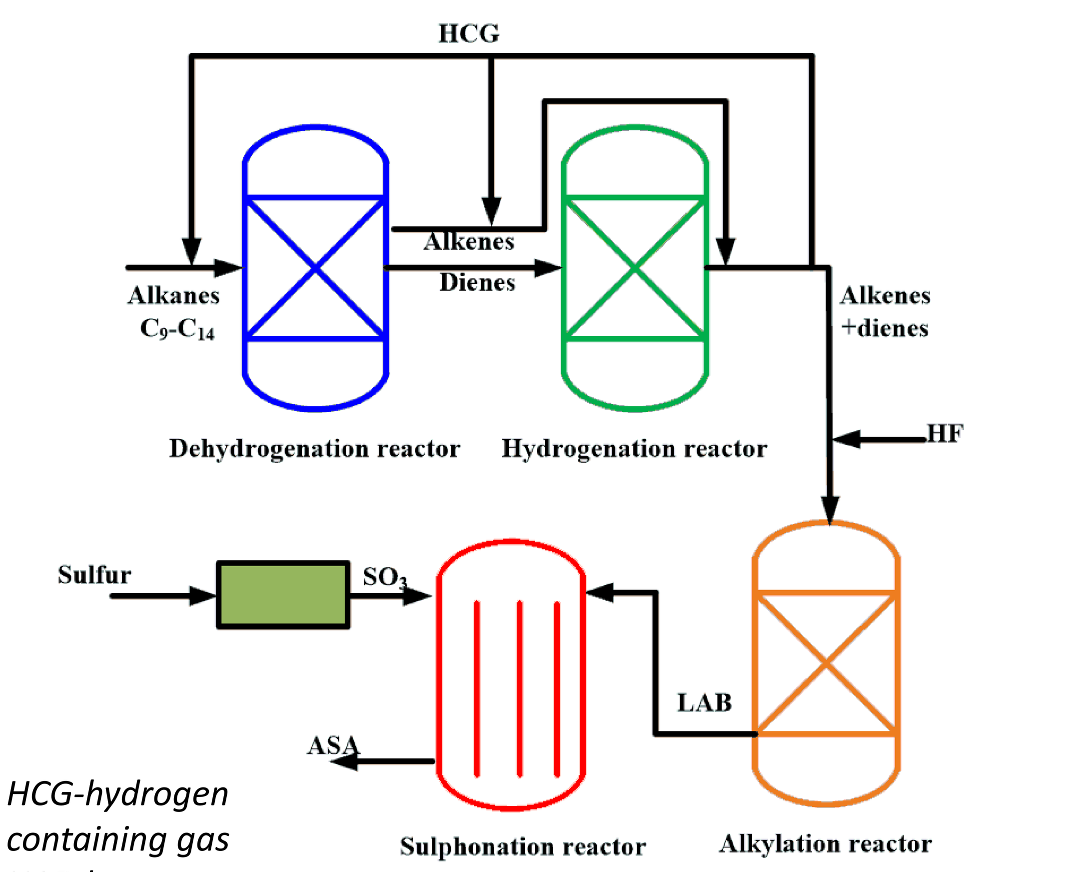

Fig. 1. Technological process block scheme

Table 1. Characteristics of sulphonation product and feed flows

Characteristics of the feed flow		Characteristics of the product flow	
LAB content in the feed flow, wt.%	96-98	**Active matter content, wt.%**	≥ 96
LAB bromine index, mg/100g.	3-5	**Unsulfonated matter content, wt.%**	≤ 2
2-phenylalkanes in LAB, wt.%	≥ 15	**H_2SO_4 content, wt.%**	≤ 2
Linear isomer in LAB, wt.%	≥ 93	**ABSA color, Klett units**	≥ 80
SO_3/LAB molar ratio, mole-mole	0.98-1.05	**ABSA viscosity, cSt**	≤ 175

The purpose of present work was to show how SO_3/LAB molar ratio in the sulfonation reactor influences the sulfonation process performance.

RESEARCH METHODS

The research was performed using the computer modeling system of LAB sulfonation process.

$$G\frac{\partial C_i}{\partial Z}+G\frac{\partial C_i}{\partial V}=\sum_j W_j\cdot a_j$$

$$G\frac{\partial T}{\partial Z}+G\frac{\partial T}{\partial V}=\frac{1}{C_p}\sum_j W_j\cdot \Delta H_j\cdot a_j$$

$Z=0,\ C_i=C_i^{in},\ T=T^{in};$

$V=0,\ C_i=C_i^{in},\ T=T^{in}.$

Here the activity of reaction mixture is defined as:

$$a_j=e^{-\alpha_j C_{v.c.}},$$

If $Z=0$ $C_{v.c.}=0$, $a=1$.

Here a_j – change in the rate of j-th reaction with the viscous component accumulation; $C_{v.c.}$ – concentration of high viscous component, mole/l; G – flow rate of raw materials, kg/h; W_j – rate of the j-th reaction, mole/(m^3·sec); ΔH_j – heat effect of the j-th reaction, K; T – temperature, K; T^{in} – initial temperature, K; C^{in} – initial concentration, mole/l.

The concentration of high viscosity components is calculated via mathematical model. If the current concentration is less the critical value, we fix this concentration as the initial value and repeat calculations using the same feedstock composition and technological modes. The critical concentration of the highly viscous component is the signal to stop the forecasting calculations. The number of such calculation cycles is the number of days between reactor washings.

RESULTS AND DISCUSSION

The SO_3/LAB molar ratio determines the medium acidity and finally the concentration of the viscosity components (the sulfones formation accelerates with the growth of the medium acidity). We use the SO_3/LAB molar ratio as this is one of the most important and measured technological parameters. From the illustrative results given below we can see how the optimal conditions depend on the content of aromatics in the feed flow and amount of accumulated high viscosity components; see Fig. 2 and Tab. 2.

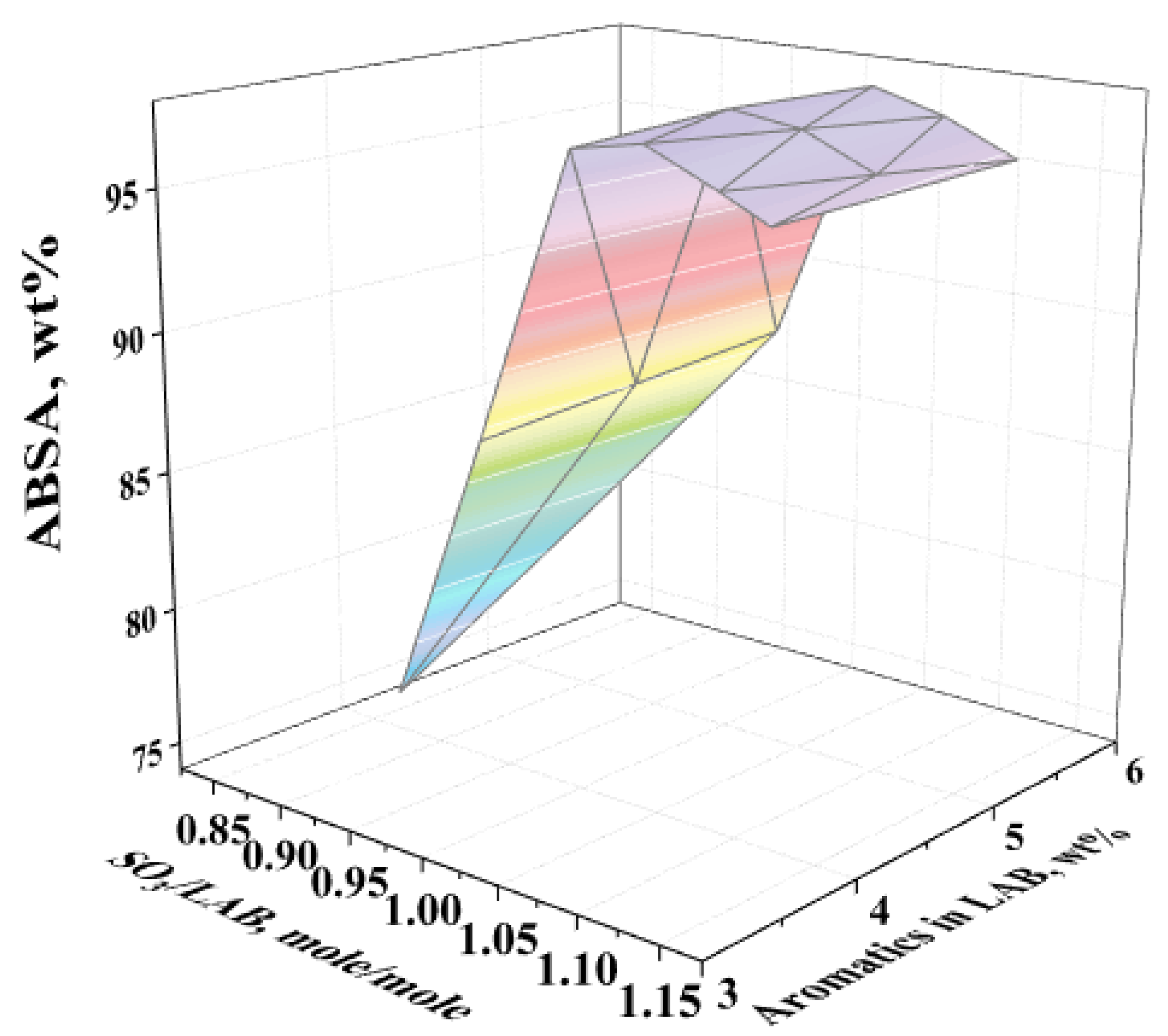

Fig. 2. ABSA content in the feed flow depending on the amount of accumulated high viscosity component and aromatics content in the feed flow.

Table 2. Effect of optimal SO_3/LAB molar ratio maintaining (model calculations)

Day of the period between reactor washings	Concentration of the accumulated high viscosity component, wt.%			Optimal sulfur flow rate to be converted to SO_3, kg/h		
	Feed 1	Feed 2	Feed 3	Feed 1	Feed 2	Feed 3
1	0.003	0.004	0.005	371.7	371.8	372.1
2	0.005	0.006	0.007	372.2	372.5	372.8
3	0.007	0.008	0.01	372.8	373.2	373.6
4	0.008	0.01	0.012	373.4	373.9	374.4
5	0.010	0.012	0.014	373.9	374.7	375.2
6	0.011	0.014	0.016	374.5	375.4	376
7	0.013	0.015	0.018	375.1	376.2	376.8
8	0.014	0.017	0.02	375.8	377	377.8
9	0.016	0.019	0.021	376.4	377.9	378.8
10	0.017	0.021	0.023	377.1	378.8	380.1
11	0.018	0.022		377.7	379.7	
12	0.020	0.024		378.5	380.8	
13	0.021			379.2		
14	0.022			380.0		
15	0.024			380.9		

The amount of sulfur to be converted into SO3 grows along with accumulation of high viscosity component between the reactor washings. This balances the reaction rates and keeps the ASA content in the product flow at minimum required constant level (96 wt.%). It is noticeable that for the feed flow 3 with high content of undesirable alkylaromatics the optimal amount of sulfur is the highest, in contrast to number of days between reactor washings.