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FORMATION OF TETRALINES AND SULFONES DEPENDING ON THE CONSTRUSTION OF THE LINEAR ALKYLBENZENES FILM SULFONATION REACTOR

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LINAER ALKYLBENZENE SULFONIC ACID MANUFACTURING

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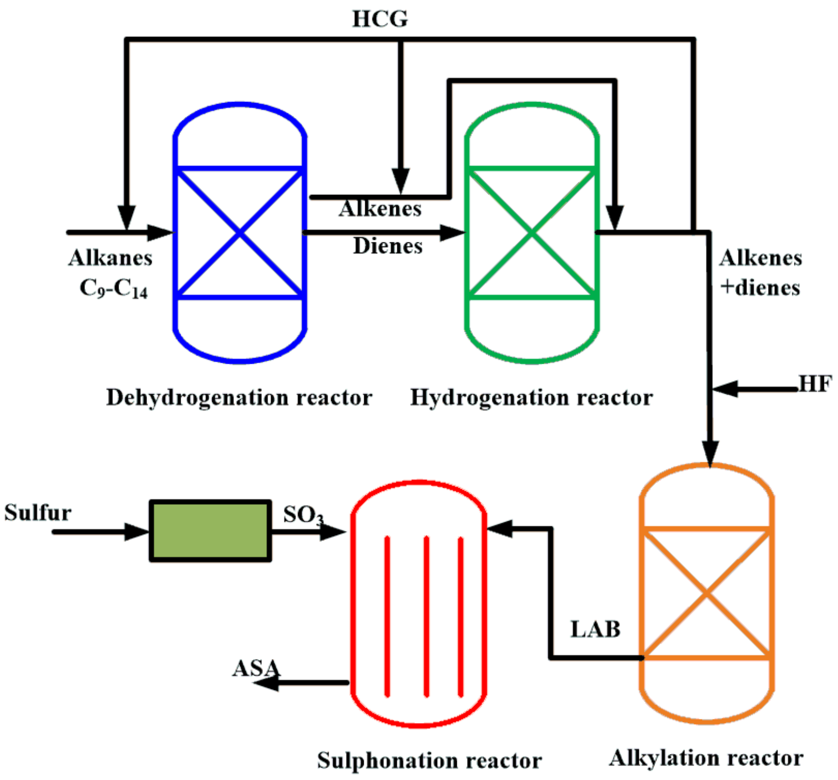

Fig. 1. Technological process block scheme

HCG-hydrogen containing gas
HAR-heavy aromatics

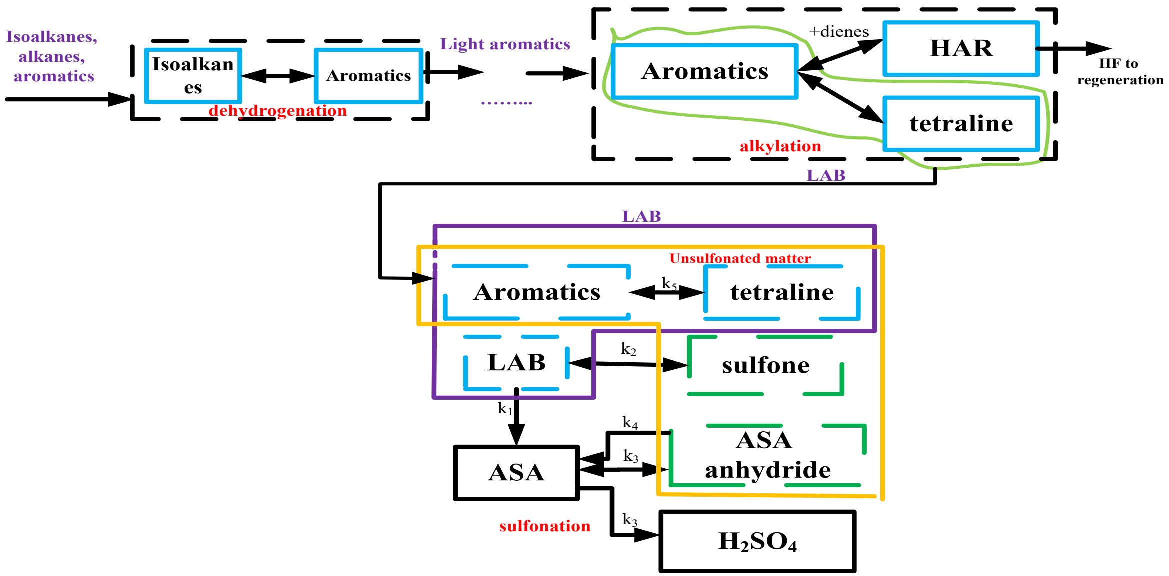

Fig. 2. Transformation of the side substances during Pt-catalyzed dehydrogenation, HF-catalyzed alkylation, and sulfonation.

Problem of highly viscous components formation

The isoalkanes contained in the dehydrogenation feedstock are converted into light aromatics at this production stage. Because of dealkylation and subsequent polymerization, these compounds form **tetralines** in the alkylation reactor.
The tetralines are highly viscous by-products that disrupt the structure of the organic liquid film in the reactor.

SULPHONATION PRODUCT AND FEED FLOWS

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 the sulfonation reactor construction influences the process performance.

SULFONATION MATHEMATICAL MODEL

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;

Wj – 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.

RESULTS AND DISCUSSION

Table 2. Varying the design parameters of the sulfonation reactor

LAB flowrate, kg/hour	**3500**					
Tube diameter, mm	25	27	31	35	43	61
Number of tubes	120	100	80	60	40	20
General reaction volume, m^3	0.353					
Surface, m^2	56.5	51.6	46.1	40.0	32.6	23.1
Contact time, sec	27.0	25.4	23.7	21.5	18.9	15.0
Film thin, mm	0.57	0.59	0.61	0.64	0.69	0.77
LAB flowrate to one tube, $m^3/sec \cdot 10^5$	0.95	1.14	1.43	1.91	2.86	5.72
Film velocity, m/sec	0.22	0.23	0.25	0.27	0.31	0.39
Gas velocity, m/sec	77.96					
Re of the film	96	105	117	135	166	235
Re of gas$\cdot 10^{-5}$	1.05	1.16	1.30	1.50	1.85	2.63
Mass transfer coefficient, kg·sec/m2$\cdot 10^2$	1.73	1.79	1.85	1.95	2.08	2.34

RESULTS AND DISCUSSION

Table 3. Modeling results

Reactor construction type	ABSA concentration, %wt.	The concentration of the viscous component on the last day of the cycle, %wt · 10^3	Unsulfurated matter concentration, %wt.	H_2SO_4 concentration, %wt.
d = 25 mm, n = 120	97.38	–	1.60	0.70
d = 25 mm, n = 120	97.33	5.97	1.84	0.67
d = 27 mm, n = 100	97.34	5.57	1.82	0.70
d = 31 mm, n = 80	97.34	5.15	1.84	0.67
d = 35 mm, n = 60	97.34	4.61	1.86	0.,65
d = 43 mm, n = 40	97.32	3.97	1.90	0.61
d = 61 mm, n = 20	97.25	3.04	1.95	0.56

THANK YOU FOR ATTENTION!