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ISOBARIC HEAT CAPACITY OF ALIPHATIC ALCOHOLS AND THEIR BINARY MIXTURES

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ABSTRACT

The pure alcohols and their mutual mixtures are alternative perspective materials. They are also cooling agents in absorption refrigeratory equipments and full pumps. The study of thermal properties of aliphatic alcohols and their mutual mixtures attracts the attention of both the researchers engaged in different fields and design engineers of chemical, petrochemical, power, and other industries.The information on the properties of such solutions is required for designing and optimization of many production processes.

KEY WORDS:

aliphatic alcohols, binary mixtures, density ,isobaric heat capacity.

1.INTRODUCTION

In spite of widely using aliphatic alcohols and their binary mixtures, their thermophysical properties are poorly studied. To close this gap, an experimental investigation of isobaric heat capacity of aliphatic alcohols (methanol, isopropanol, isobutanol, isopentanol, n.hexanol) and binary mixtures (n.butanol+n.hexanol, n.butanol+n.octanol, isobutanol+n.hexanol and isobutanol+n.octanol) on the consentration 25%, 50%, 75% by mass in a liquid state in the range of temperatures 303-523 K and pressures 0.1-50 MPa has been carried out.

2.MEASUREMENT

The measurements have been carried out on the installation offered by Naziev and realizing method of pulse-regular regime. The facility is a version of the experimental instrument proposed in [1,2].

The estimation of accuracy of the obtained results with respect to isobaric heat capacity was made according to the general theory of errors, and the error was 2.16%.

Agents of the chemically pure grade and additionally rectified to remove impurities were used in the experiments. The chromatographic analysis showed the content of the basic substance in the agents to be not less than 99.9% by mass.

The mixtures were prepared by the gravimetric method in the analytical balance.

The volume isobaric heat capacity (c'_p) of fluid alcohols and their binary mixtures mentioned above has been measured. The experiments has conducted on isoterms. The pitch of measurement is 25° C.

On base of receving values on volume izobaric heat capacity and literature values on density which is calculated the izobaric (mass) heat capacity (c_p) of methanol, isopropanol, isobutanol, isopentanol, n.hexanol and binary mixtures n.butanol+n.hexanol, n.butanol+n.octanol, isobutanol+n.hexanol and isobutanol+n.octanol.

Due to the absence of values on density of mixtures of isobutanol+n.hexanol and isobutanol+n.octanol to be investigated the calculation c_p (mass heat capacity) was impossible.

3.RESULTS

Results of receiving data of c'_p and c_p for indicated alcohols and binary mixtures are given in Tables 1-10.

It is imposible to notice that values of c_p for pure components (n.butanol and n.octanol) were received on this experimental installation in [3].

Since heat capacity of components and binary mixtures measure on the same installation and conditions are edential we avoid systematic errors when we treat experimental data.

The concentration dependence of isobaric volume heat capacity for these binary mixtures have complicated character. Deviation from additivity have negative taken at low temperatures. Increasing temperature we make shorter deviation from additivity for all values of pressure and in temperature range 325-343 K (for isobutanol+n.hexanol), in 338-346 K (for isobutanol+n.octanol), in 353-363 K (for n.butanol+n.hexanol) and in 363-383 K (for n.butanol+ n.octanol) concentrational effect is equal zero. If the increase of temperature continues deviation from additivity changes its direction on opposite and have positive taken and influence of concentration become to increase.

The data on isobaric heat capacity of isoalcohols (isopropanol, isobutanol and isopentanol) are described by the formula

$$c_p = A + B \cdot \rho + \sum_{i=0}^{2} E_i T^i \ , \qquad (1)$$

where ρ is the density of isoalcohols; T is the temperature; A, B and E_i are the coefficients.

The values of A,B and E are listed in Table 11.

Equation (1) describes the experimental data on c_p of the isoalcohols under investigations within the limits of the experimental error in the temperature range 303-523 K and pressures of 0.1-50 MPa.

Dependense of isobaric (mass and volume) heat capasity from pressure, temperature and concentration for mixtures n.butanol+n.hexanol and n.butanol+n.octanol is discribed by the equation

$$c_P = c_{P_1} x_1 + c_{P_2} x_2 + x_1 x_2 \left[\alpha \Delta T + \beta (50 - P) + \gamma PT + \theta \right] \qquad (2)$$

and for mixtures isobutanol+n.hexanol and isobutanol+n.octanol

$$c'_P = c'_{P_1} x_1 + c'_{P_2} x_2 + x_1 x_2 \left[\alpha \Delta T + \beta (50 - P) + \gamma PT + \theta \right] \qquad (3)$$

where c_{P_1}, c_{P_2}, c'_{P_1}, c'_{P_2} and x_1, x_2 are the isobaric (mass and volume) heat capacity and the concentration of the first and second components of the mixtures, respectively, $x_1 + x_2 = 1$; P is the pressure, MPa; $\Delta T = T - T_0$, T_0 - basic temperature, when the taken of concentration influence on mixtures c_p and c'_P is changed; α, β, γ,θ- constants for given systems.

The values of constants in equations (2) and (3) are given in Table 12.

Equations (2) and (3) describes the experimental data of c_p and c'_P for binary mixtures n.butanol+n.hexanol with error 0.7%, for n.butanol+n.octanol with error 0.9%, for isobutanol+n.hexanol with error 0.7% and for isobutanol+n.octanol with error 0.5%.

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Table 1. Experimental values of volume isobaric heat capacity (c'_p, kJ·m^{-3}· K^{-1}) of methanol and n.hexanol

T, K	P, MPa						
	0.1	5	10	20	30	40	50
				methanol			
298	1984	1991	1997	2001	1999	1996	1993
326	2065	2073	2070	2070	2055	2043	2035
347	-	2143	2130	2123	2101	2090	2078
374	-	2251	2213	2213	2166	2153	2137
396	-	2360	2301	2278	2239	2210	2202
424	-	2543	2461	2385	2332	2291	2288
444	-	2707	2628	2469	2400	2349	2351
469	-	3046	3044	2582	2484	2434	2438
497	-	-	3582	2713	2584	2536	2558
521	-	-	4944	2736	2587	2581	2578
				n.hexanol			
301	2123	2126	2129	2138	2145	2153	2162
323	2201	2204	2206	2217	2228	2238	2248
346	2260	2262	2265	2278	2291	2305	2314
372	2308	2310	2316	2330	2344	2358	2371
399	2342	2345	2349	2370	2387	2399	2417
423	2364	2368	2374	2395	2415	2430	2449
450	-	2385	2395	2419	2441	2463	2481
475	-	2399	2408	2430	2460	2485	2502
497	-	2401	2411	2436	2470	2497	2516
523	-	2400	2415	2441	2476	2510	2530

Table 2. Experimental values of mass isobaric heat capacity (c_p, $kJ \cdot kg^{-1} \cdot K^{-1}$) of methanol and n.hexanol

T, K	P, MPa						
	0.1	5	10	20	30	40	50
				methanol			
298	2.522	2.517	2.506	2.489	2.463	2.439	2.417
326	2.719	2.709	2.686	2.654	2.608	2.567	2.535
347	-	2.879	2.840	2.792	2.728	2.685	2.644
374	-	3.146	3.062	3.011	2.902	2.848	2.798
396	-	3.421	3.295	3.196	3.085	3.001	2.954
424	-	3.905	3.715	3.500	3.346	3.231	3.176
444	-	4.378	4.151	3.759	3.557	3.405	3.351
469	-	5.399	5.170	4.171	3.854	3.672	3.601
497	-	-	6.885	4.704	4.251	4.029	3.952
521	-	-	12.934	5.209	4.550	4.312	4.157
				n.hexanol			
301	2.604	2.594	2.585	2.577	2.570	2.563	2.555
323	2.747	2.737	2.729	2.719	2.712	2.705	2.698
346	2.883	2.874	2.860	2.851	2.843	2.836	2.827
372	3.031	3.017	2.998	2.986	2.976	2.966	2.957
399	3.176	3.155	3.137	3.123	3.109	3.094	3.085
423	3.303	3.280	3.261	3.240	3.224	3.207	3.198
450	-	3.437	3.413	3.379	3.358	3.341	3.323
475	-	3.597	3.562	3.510	3.485	3.461	3.435
497	-	3.750	3.700	3.628	3.595	3.567	3.535
523	-	3.941	3.873	3.776	3.727	3.695	3.657

Table 3. Experimental values of volume isobaric heat capacity (c'_p, kJ·m^{-3}· K^{-1}) of isopropanol, isobutanol and isopentanol

T, K	P, MPa						
	0.1	5	10	20	30	40	50
				isopropanol			
302	2097	2099	2101	2112	2123	2127	2131
325	2294	2292	2292	2290	2289	2285	2283
348	2471	2462	2453	2438	2434	2429	2421
368	-	2562	2543	2524	2518	2515	2506
395	-	2635	2607	2591	2591	2590	2577
418	-	2648	2625	2617	2627	2624	2619
446	-	2612	2586	2587	2607	2606	2610
470	-	2521	2511	2525	2550	2551	2562
496	-	2296	2375	2423	2461	2464	2482
521	-	-	2180	2302	2357	2373	2396
				isobutanol			
302	2005	2006	2007	2013	2021	2033	2040
324	2186	2180	2169	2167	2166	2166	2165
349	2369	2342	2319	2307	2293	2289	2274
368	2468	2430	2398	2376	2355	2338	2324
396	-	2491	2458	2432	2411	2390	2376
419	-	2478	2453	2441	2429	2416	2406
447	-	2414	2413	2428	2424	2419	2417
470	-	2326	2348	2380	2396	2402	2405
497	-	2209	2262	2316	2353	2371	2377
521	-	2086	2174	2245	2299	2329	2343
				isopentanol			
301	1954	1957	1958	1967	1972	1975	1981
321	2087	2088	2089	2099	2103	2106	2109
345	2204	2206	2206	2212	2215	2218	2217
370	2288	2291	2290	2295	2295	2298	2295
396	2361	2349	2344	2352	2350	2353	2356
420	-	2371	2367	2378	2376	2376	2376
447	-	2364	2366	2383	2383	2386	2386
471	-	2334	2343	2370	2375	2380	2383
496	-	2278	2302	2341	2356	2365	2366
519	-	2206	2250	2306	2331	2342	2343

Table 4. Experimental values of mass isobaric heat capacity (c_p, $kJ \cdot kg^{-1} \cdot K^{-1}$) of isopropanol, isobutanol and isopentanol

T, K	P, MPa						
	0.1	5	10	20	30	40	50
isopropanol							
302	2.693	2.680	2.669	2.656	2.645	2.627	2.613
325	3.024	3.002	2.982	2.945	2.913	2.881	2.856
348	3.365	3.326	3.289	3.223	3.176	3.134	3.100
367	-	3.558	3.501	3.417	3.359	3.314	3.270
395	-	3.837	3.751	3.648	3.581	3.526	3.470
418	-	4.050	3.948	3.828	3.761	3.689	3.625
446	-	4.299	4.145	3.984	3.902	3.813	3.747
470	-	4.530	4.309	4.093	3.984	3.878	3.810
496	-	4.859	4.492	4.194	4.052	3.924	3.844
521	-	-	4.681	4.273	4.098	3.949	3.856
isobutanol							
302	2.521	2.511	2.500	2.485	2.474	2.469	2.463
324	2.814	2.789	2.759	2.728	2.703	2.680	2.661
349	3.125	3.069	3.019	2.967	2.921	2.879	2.844
368	3.348	3.268	3.200	3.125	3.063	3.008	2.963
396	-	3.477	3.397	3.304	3.228	3.161	3.112
419	-	3.595	3.513	3.422	3.346	3.280	3.225
447	-	3.701	3.622	3.535	3.463	3.397	3.344
470	-	3.788	3.701	3.616	3.546	3.483	3.425
497	-	3.913	3.798	3.699	3.625	3.562	3.500
521	-	4.098	3.912	3.766	3.688	3.624	3.561
isopentanol							
301	2.437	2.427	2.415	2.407	2.394	2.383	2.373
321	2.654	2.639	2.626	2.612	2.596	2.581	2.567
345	2.872	2.855	2.837	2.814	2.792	2.771	2.750
370	3.069	3.046	3.021	2.989	2.958	2.931	2.905
396	3.273	3.223	3.188	3.149	3.107	3.073	3.042
420	-	3.361	3.318	3.273	3.222	3.182	3.147
447	-	3.498	3.450	3.396	3.335	3.288	3.247
471	-	3.607	3.554	3.492	3.425	3.371	3.323
496	-	3.716	3.657	3.585	3.513	3.450	3.392
519	-	3.815	3.748	3.668	3.590	3.518	3.450

Table 5. Experimental values of volume isobaric heat capacity (c'_p, $kJ \cdot m^{-3} \cdot K^{-1}$) of binary mixtures n.butanol + n.hexanol

T, K	P, MPa						
	0.1	5	10	20	30	40	50
25%n.butanol +75%n.hexanol							
303	2062	2063	2064	2075	2084	2088	2095
326	2159	2159	2161	2172	2182	2192	2196
348	2239	2239	2242	2253	2267	2279	2285
377	2336	2334	2338	2352	2368	2380	2394
401	2403	2395	2401	2413	2429	2444	2460
427	-	2453	2456	2468	2487	2504	2511
448	-	2489	2494	2502	2521	2541	2558
473	-	2505	2512	2528	2549	2569	2589
498	-	2521	2532	2554	2583	2604	2618
521	-	2526	2547	2576	2616	2632	2649
50%n.butanol +50%n.hexanol							
302	2001	2000	2003	2012	2020	2027	2031
320	2090	2089	2091	2101	2108	2120	2124
347	2215	2213	2217	2228	2238	2254	2262
371	2316	2311	2315	2328	2343	2359	2370
397	2415	2402	2407	2421	2438	2455	2468
418	-	2468	2472	2487	2500	2519	2535
449	-	2539	2545	2556	2569	2589	2609
468	-	2575	2581	2595	2605	2628	2647
500	-	2601	2612	2640	2654	2676	2696
522	-	2594	2618	2655	2673	2703	2725
75%n.butanol +25%n.hexanol							
304	1975	1975	1978	1985	1994	1998	2005
321	2060	2057	2062	2070	2080	2089	2096
347	2182	2180	2186	2197	2214	2224	2235
370	2288	2279	2283	2302	2320	2336	2349
401	2403	2390	2396	2417	2439	2457	2473
421	-	2453	2460	2477	2496	2518	2535
447	-	2524	2529	2544	2560	2585	2605
471	-	2556	2571	2587	2604	2627	2652
496	-	2563	2593	2623	2640	2666	2687
521	-	2543	2594	2639	2669	2687	2705

Table 6. Experimental values of mass isobaric heat capacity (c_p, $kJ \cdot kg^{-1} \cdot K^{-1}$) of binary mixtures n.butanol + n.hexanol

T, K	P, MPa						
	0.1	5	10	20	30	40	50
25%n.butanol +75%n.hexanol							
303	2.536	2.524	2.519	2.508	2.502	2.491	2.482
326	2.709	2.695	2.684	2.656	2.667	2.661	2.647
348	2.870	2.856	2.843	2.834	2.826	2.818	2.804
377	3.096	3.073	3.055	3.041	3.030	3.017	3.007
401	3.281	3.239	3.223	3.196	3.181	3.167	3.155
427	-	3.443	3.413	3.372	3.349	3.331	3.316
448	-	3.608	3.569	3.516	3.480	3.459	3.439
473	-	3.801	3.752	3.682	3.637	3.603	3.577
498	-	4.018	3.952	3.861	3.807	3.759	3.717
521	-	4.228	4.147	4.032	3.973	3.906	3.843
50%n.butanol +50%n.hexanol							
302	2.474	2.460	2.451	2.443	2.433	2.424	2.415
320	2.621	2.605	2.596	2.586	2.577	2.569	2.561
347	2.849	2.831	2.819	2.807	2.799	2.789	2.779
371	3.061	3.036	3.019	3.005	2.996	2.985	2.971
397	3.301	3.255	3.236	3.212	3.195	3.183	3.169
418	-	3.438	3.415	3.373	3.351	3.334	3.319
449	-	3.719	3.677	3.607	3.570	3.543	3.523
468	-	3.908	3.853	3.765	3.712	3.677	3.650
500	-	4.210	4.124	4.015	3.937	3.886	3.846
522	-	4.429	4.331	4.192	4.105	4.036	3.982
75%n.butanol +25%n.hexanol							
304	2.453	2.439	2.431	2.421	2.413	2.403	2.393
321	2.604	2.590	2.580	2.568	2.560	2.551	2.541
347	2.836	2.817	2.804	2.793	2.785	2.773	2.763
370	3.054	3.023	3.009	2.995	2.986	2.977	2.965
401	3.342	3.297	3.277	3.254	3.239	3.226	2.212
421	-	3.478	3.450	3.414	3.389	3.373	3.356
447	-	3.739	3.697	3.637	3.592	3.570	3.547
471	-	3.968	3.915	3.833	3.771	3.735	3.709
496	-	4.208	4.143	4.031	3.958	3.909	3.867
521	-	4.462	4.373	4.228	4.149	4.071	4.014

Table 7. Experimental values of volume isobaric heat capacity (c'_p, kJ·m^{-3}· K^{-1}) of binary mixtures n.butanol + n.octanol

T, K	P, MPa						
	0.1	5	10	20	30	40	50
25%n.butanol +75%n.octanol							
305	2026	2028	2031	2035	2043	2052	2058
323	2093	2096	2099	2104	2112	2120	2127
347	2172	2175	2180	2186	2195	2202	2212
372	2252	2255	2260	2267	2277	2283	2291
399	2329	2332	2338	2346	2356	2364	2371
424	-	2396	2402	2409	2420	2428	2438
446	-	2444	2451	2459	2469	2479	2490
475	-	2494	2501	2510	2520	2533	2548
498	-	2524	2530	2541	2552	2568	2583
521	-	2549	2556	2566	2580	2598	2613
50%n.butanol +50% n.octanol							
303	1992	1995	1999	2004	2008	2013	2021
324	2078	2081	2084	2088	2096	2103	2110
348	2173	2176	2179	2185	2195	2203	2212
376	2276	2279	2284	2297	2307	2315	2325
400	2362	2364	2370	2387	2398	2407	2418
422	-	2440	2448	2465	2480	2490	2503
450	-	2510	2522	2536	2555	2567	2581
469	-	2540	2555	2571	2590	2605	2616
499	-	2564	2584	2606	2624	2641	2648
523	-	2557	2585	2617	2634	2650	2656
75%n.butanol +25% n.octanol							
303	1975	1976	1979	1988	2000	2009	2016
322	2054	2055	2058	2067	2078	2089	2096
347	2158	2160	2164	2175	2185	2195	2206
372	2259	2262	2264	2276	2290	2301	2313
398	2351	2356	2361	2374	2391	2407	2423
424	-	2438	2445	2462	2483	2505	2524
448	-	2485	2497	2519	2538	2563	2585
474	-	2511	2528	2552	2575	2598	2621
497	-	2512	2533	2564	2591	2614	2637
523	-	2486	2520	2559	2593	2620	2641

Table 8. Experimental values of mass isobaric heat capacity (c_p, $kJ \cdot kg^{-1} \cdot K^{-1}$) of binary mixtures n.butanol + n.octanol

T, K	P, MPa						
	0.1	5	10	20	30	40	50
25%n.butanol +75%n.octanol							
305	2.492	2.485	2.474	2.463	2.455	2.447	2.441
323	2.609	2.600	2.594	2.578	2.568	2.559	2.552
347	2.769	2.758	2.745	2.731	2.719	2.708	2.699
372	2.946	2.929	2.920	2.901	2.884	2.869	2.857
399	3.146	3.130	3.114	3.084	3.065	3.047	3.030
424	-	3.313	3.289	3.254	3.228	3.199	3.184
446	-	3.483	3.457	3.408	3.370	3.337	3.315
475	-	3.720	3.678	3.608	3.555	3.516	3.486
498	-	3.906	3.843	3.752	3.690	3.648	3.614
521	-	4.117	4.023	3.906	3.825	3.774	3.728
50%n.butanol +50% n.octanol							
303	2.449	2.441	2.431	2.420	2.413	2.404	2.399
324	2.607	2.597	2.583	2.570	2.561	2.551	2.543
348	2.792	2.779	2.765	2.750	2.738	2.726	2.716
376	3.019	3.001	2.987	2.969	2.953	2.934	2.922
400	3.225	3.207	3.188	3.166	3.143	3.119	3.105
422	-	3.407	3.385	3.355	3.327	3.297	3.281
450	-	3.650	3.619	3.569	3.534	3.501	3.472
469	-	3.814	3.777	3.709	3.662	3.622	3.583
499	-	4.073	4.016	3.920	3.847	3.791	3.736
523	-	4.274	4.199	4.084	3.988	3.917	3.849
75%n.butanol +25% n.octanol							
303	2.426	2.419	2.412	2.402	2.395	2.390	2.383
322	2.591	2.581	2.569	2.557	2.549	2.544	2.536
347	2.793	2.781	2.767	2.753	2.741	2.731	2.723
372	3.008	2.989	2.976	2.957	2.943	2.929	2.921
398	3.242	3.220	3.199	3.177	3.161	3.148	3.135
424	-	3.453	3.429	3.399	3.374	3.358	3.344
448	-	3.669	3.638	3.591	3.554	3.531	3.514
474	-	3.899	3.851	3.778	3.730	3.695	3.669
497	-	4.108	4.037	3.935	3.874	3.825	3.788
523	-	4.318	4.222	4.088	4.011	3.950	3.898

Table 9. Experimental values of volume isobaric heat capacity (c'_p, kJ·m^{-3}· K^{-1}) of binary mixtures isobutanol + n.hexanol

T, K	P, MPa						
	0.1	5	10	20	30	40	50
25%n.isobutanol +75%n.hexanol							
303	2082	2085	2088	2096	2103	2112	2120
323	2188	2189	2191	2200	2207	2215	2223
345	2282	2282	2281	2287	2293	2300	2302
373	2377	2358	2355	2359	2362	2378	2379
397	2420	2395	2392	2397	2405	2412	2415
423	-	2414	2416	2425	2440	2450	2456
449	-	2421	2429	2442	2464	2476	2487
473	-	2421	2433	2452	2477	2494	2506
498	-	2412	2432	2455	2484	2507	2520
523	-	2396	2422	2453	2487	2517	2531
50%n.isobutanol +50%n.hexanol							
303	2048	2050	2055	2062	2069	2078	2085
321	2169	2167	2162	2173	2176	2183	2190
349	2322	2320	2309	2306	2304	2307	2302
373	2416	2402	2385	2375	2370	2367	2363
398	-	2437	2428	2421	2415	2413	2411
424	-	2445	2442	2447	2449	2451	2452
448	-	2438	2441	2459	2468	2474	2479
473	-	2419	2431	2460	2477	2487	2494
497	-	2387	2412	2451	2475	2491	2501
521	-	2341	2383	2426	2462	2488	2502
75%n.isobutanol +25%n.hexanol							
303	2024	2027	2032	2037	2044	2054	2062
323	2177	2173	2164	2168	2171	2175	2179
347	2335	2327	2306	2298	2294	2291	2280
371	2453	2430	2408	2382	2366	2354	2345
399	-	2470	2450	2437	2424	2412	2402
423	-	2466	2454	2455	2449	2442	2435
446	-	2436	2440	2453	2456	2451	2454
472	-	2385	2410	2437	2449	2452	2461
499	-	2299	2355	2400	2426	2441	2454
523	-	2224	2289	2348	2390	2421	2436

Table10. Experimental values of volume isobaric heat capacity (c'_p, kJ·m^{-3}· K^{-1}) of binary mixtures isobutanol + n.octanol

T, K	P, MPa						
	0.1	5	10	20	30	40	50
25%n.isobutanol +75%n.octanol							
303	2030	2032	2036	2043	2050	2059	2065
323	2120	2121	2122	2130	2137	2143	2151
348	2221	2221	2219	2226	2231	2235	2243
372	2295	2291	2288	2293	2301	2307	2314
399	2355	2343	2340	2345	2358	2366	2377
422	-	2373	2374	2385	2399	2412	2423
449	-	2396	2403	2423	2438	2452	2468
474	-	2404	2419	2445	2464	2482	2499
497	-	2403	2425	2456	2479	2500	2518
522	-	2391	2419	2454	2485	2510	2529
50%n.isobutanol +50% n.octanol							
303	2011	2013	2016	2020	2028	2035	2041
327	2150	2152	2147	2153	2155	2160	2165
348	2269	2260	2255	2256	2254	2254	2254
371	2364	2350	2337	2333	2332	2331	2329
397	2428	2403	2391	2387	2391	2392	2392
424	-	2428	2422	2430	2436	2440	2444
449	-	2431	2435	2452	2464	2471	2480
474	-	2418	2434	2460	2480	2490	2504
497	-	2393	2419	2456	2481	2497	2514
522	-	2353	2390	2435	2471	2494	2510
75%n.isobutanol +25% n.octanol							
303	2004	2005	2011	2013	2021	2029	2035
325	2164	2160	2153	2157	2154	2161	2162
349	2321	2304	2292	2288	2277	2274	2268
373	2432	2404	2387	2367	2359	2350	2344
398	2497	2454	2433	2416	2413	2403	2397
424	-	2457	2447	2447	2445	2440	2437
447	-	2435	2439	2451	2456	2458	2460
472	-	2388	2409	2435	2456	2462	2470
498	-	2322	2359	2404	2440	2452	2464
523	-	2235	2300	2360	2404	2430	2442

Table 11. The value of coefficients for equation (1)

Alcohols	Coefficients				
	A	B	E_0	E_1	E_2
isopropanol	7116.43	-5.6393	-6733.904	34.7053	-0.041
isobutanol	6212.64	-4.5951	-4706.817	24.2050	-0.0281
isopentanol	5421.73	-3.6867	-3913.890	19.2762	-0.0207

Table 12. The value of constants for equations (2) and (3)

Systems	Constants				Basic tempe-rature
	α	β	γ	θ	
n.butanol+n.hexanol	-7.00453	-24.2688	-0.06443	1228.84	358
n.butanol+n.octanol	-5.66384	-29.8738	-0.07395	1520.11	373
isobutanol+n.hexanol	-2.28220	-6.702374	-0.01546	234.92	333
isobutanol+n.octanol	-2.581580	-2.876776	-0.00909	150.24	343