**ЛАБОРАТОРНАЯ РАБОТА № 3**

**Идентификация кинетических параметров при математическом моделировании химических превращений**

**Задание**

1. Составьте кинетическую модель в соответствии с представленной схемой превращений.
2. Решите полученную кинетическую модель на заданном интервале по времени при заданных начальных концентрациях компонентов, участвующих в химических превращениях, методом Рунге-Кутты.
3. Определите кинетические параметры химических превращений, используя генетический алгоритм и данные по наблюдаемым концентрациям химических веществ, участвующих в реакциях, при различном времени процесса.
4. Постройте зависимости изменения концентраций химических веществ от времени протекания реакций по исходным данных и результатам расчета.

**Вариант 1**

Схема превращений:

Начальные концентрации:

|  |  |  |  |
| --- | --- | --- | --- |
| C10H22 | C10H20 | C10H18 | H2 |
| 1.0 | 0.0 | 0.0 | 0.0 |

Время процесса 1.0 сек.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Время, сек. | C10H22 | C10H20 | C10H18 | H2 |
| 0.0 | 1.000000 | 0.000000 | 0.000000 | 0.000000 |
| 0.1 | 0.882497 | 0.112549 | 0.004954 | 0.122458 |
| 0.2 | 0.778800 | 0.202702 | 0.018498 | 0.239698 |
| 0.3 | 0.687290 | 0.273834 | 0.038876 | 0.351587 |
| 0.4 | 0.606523 | 0.328894 | 0.064583 | 0.458060 |
| 0.5 | 0.535250 | 0.370369 | 0.094381 | 0.559131 |
| 0.6 | 0.472363 | 0.400412 | 0.127225 | 0.654862 |
| 0.7 | 0.416866 | 0.420927 | 0.162207 | 0.745340 |
| 0.8 | 0.367882 | 0.433546 | 0.198571 | 0.830689 |
| 0.9 | 0.324655 | 0.439622 | 0.235723 | 0.911068 |
| 1.0 | 0.286508 | 0.440335 | 0.273157 | 0.986649 |

**Вариант 2**

Схема превращений:

Начальные концентрации:

|  |  |  |  |
| --- | --- | --- | --- |
| C11H24 | C11H22 | C11H20 | H2 |
| 0.8 | 0.1 | 0.1 | 0.0 |

Время процесса 1.0 сек.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Время, сек. | C11H24 | C11H22 | C11H20 | H2 |
| 0.0 | 0.800000 | 0.100000 | 0.100000 | 0.000000 |
| 0.1 | 0.720260 | 0.172199 | 0.107542 | 0.087282 |
| 0.2 | 0.648467 | 0.232803 | 0.118729 | 0.170262 |
| 0.3 | 0.583815 | 0.283238 | 0.132947 | 0.249132 |
| 0.4 | 0.525593 | 0.324735 | 0.149672 | 0.324079 |
| 0.5 | 0.473189 | 0.358338 | 0.168473 | 0.395285 |
| 0.6 | 0.426033 | 0.385012 | 0.188955 | 0.462922 |
| 0.7 | 0.383595 | 0.405651 | 0.210754 | 0.527158 |
| 0.8 | 0.345388 | 0.421070 | 0.233541 | 0.588153 |
| 0.9 | 0.310968 | 0.432005 | 0.257027 | 0.646059 |
| 1.0 | 0.279972 | 0.439030 | 0.280998 | 0.701026 |

**Вариант 3**

Схема превращений:

Начальные концентрации:

|  |  |  |  |
| --- | --- | --- | --- |
| C12H26 | C12H24 | C12H22 | H2 |
| 1.0 | 0.0 | 0.0 | 0.0 |

Время процесса 1.5 сек.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Время, сек. | C12H26 | C12H24 | C12H22 | H2 |
| 0.00 | 1.000000 | 0.000000 | 0.000000 | 0.000000 |
| 0.15 | 0.804527 | 0.180754 | 0.014719 | 0.210193 |
| 0.30 | 0.647262 | 0.300534 | 0.052204 | 0.404941 |
| 0.45 | 0.520733 | 0.374912 | 0.104355 | 0.583622 |
| 0.60 | 0.418956 | 0.415813 | 0.165231 | 0.746276 |
| 0.75 | 0.337032 | 0.432629 | 0.230339 | 0.893307 |
| 0.90 | 0.271153 | 0.432167 | 0.296680 | 1.025527 |
| 1.05 | 0.218183 | 0.419775 | 0.362042 | 1.143859 |
| 1.20 | 0.175526 | 0.399679 | 0.424795 | 1.249269 |
| 1.35 | 0.141217 | 0.374700 | 0.484083 | 1.342866 |
| 1.50 | 0.113622 | 0.347041 | 0.539336 | 1.425714 |

**Вариант 4**

Схема превращений:

Начальные концентрации:

|  |  |  |  |
| --- | --- | --- | --- |
| C13H28 | C13H26 | C13H24 | H2 |
| 1.0 | 0.0 | 0.0 | 0.0 |

Время процесса 2.0 сек.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Время, сек. | C13H28 | C13H26 | C13H24 | H2 |
| 0.0 | 1.000000 | 0.000000 | 0.000000 | 0.000000 |
| 0.2 | 0.637629 | 0.343481 | 0.018890 | 0.381261 |
| 0.4 | 0.406558 | 0.529700 | 0.063742 | 0.657184 |
| 0.6 | 0.259169 | 0.618828 | 0.122003 | 0.862834 |
| 0.8 | 0.165332 | 0.648634 | 0.186034 | 1.020702 |
| 1.0 | 0.105361 | 0.643538 | 0.251101 | 1.145740 |
| 1.2 | 0.067244 | 0.618173 | 0.314583 | 1.247338 |
| 1.4 | 0.042878 | 0.582219 | 0.374904 | 1.332026 |
| 1.6 | 0.027350 | 0.541318 | 0.431333 | 1.403983 |
| 1.8 | 0.017465 | 0.498969 | 0.483566 | 1.466101 |
| 2.0 | 0.011137 | 0.457303 | 0.531560 | 1.520423 |

**Вариант 5**

Схема превращений:

Начальные концентрации:

|  |  |  |  |
| --- | --- | --- | --- |
| C9H16 | H2 | C9H18 | C9H20 |
| 1.0 | 1.0 | 0.0 | 0.0 |

Время процесса 1.0 сек.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Время, сек. | C9H16 | H2 | C9H18 | C9H20 |
| 0.0 | 1.000000 | 1.000000 | 0.000000 | 0.000000 |
| 0.1 | 0.757845 | 0.719811 | 0.242155 | 0.038034 |
| 0.2 | 0.621388 | 0.515458 | 0.378612 | 0.105930 |
| 0.3 | 0.538828 | 0.367934 | 0.461172 | 0.170893 |
| 0.4 | 0.487262 | 0.262232 | 0.512738 | 0.225030 |
| 0.5 | 0.453439 | 0.186649 | 0.546561 | 0.266791 |
| 0.6 | 0.430701 | 0.132676 | 0.569299 | 0.298025 |
| 0.7 | 0.415460 | 0.094426 | 0.584540 | 0.321034 |
| 0.8 | 0.404812 | 0.067089 | 0.595188 | 0.337723 |
| 0.9 | 0.397410 | 0.047656 | 0.602590 | 0.349753 |
| 1.0 | 0.392259 | 0.033889 | 0.607741 | 0.358370 |

**Вариант 6**

Схема превращений:

Начальные концентрации:

|  |  |  |  |
| --- | --- | --- | --- |
| C10H18 | H2 | C10H20 | C10H22 |
| 1.0 | 1.0 | 0.0 | 0.0 |

Время процесса 1.5 сек.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Время, сек. | C10H18 | H2 | C10H20 | C10H22 |
| 0.00 | 1.000000 | 1.000000 | 0.000000 | 0.000000 |
| 0.15 | 0.730765 | 0.692530 | 0.269235 | 0.038235 |
| 0.30 | 0.587880 | 0.484581 | 0.412120 | 0.103299 |
| 0.45 | 0.504379 | 0.340886 | 0.495621 | 0.163492 |
| 0.60 | 0.453081 | 0.240731 | 0.546919 | 0.212350 |
| 0.75 | 0.419721 | 0.170207 | 0.580279 | 0.249514 |
| 0.90 | 0.397888 | 0.120686 | 0.602112 | 0.277201 |
| 1.05 | 0.382968 | 0.085569 | 0.617032 | 0.297399 |
| 1.20 | 0.372705 | 0.060687 | 0.627295 | 0.312019 |
| 1.35 | 0.365667 | 0.043155 | 0.634333 | 0.322512 |
| 1.50 | 0.360695 | 0.030648 | 0.639305 | 0.330048 |

**Вариант 7**

Схема превращений:

Начальные концентрации:

|  |  |  |  |
| --- | --- | --- | --- |
| C11H20 | H2 | C11H22 | C11H24 |
| 1.0 | 1.0 | 0.0 | 0.0 |

Время процесса 2.0 сек.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Время, сек. | C11H20 | H2 | C11H22 | C11H24 |
| 0.0 | 1.000000 | 1.000000 | 0.000000 | 0.000000 |
| 0.2 | 0.707191 | 0.677625 | 0.292809 | 0.029566 |
| 0.4 | 0.556757 | 0.477936 | 0.443243 | 0.078821 |
| 0.6 | 0.469490 | 0.344501 | 0.530510 | 0.124989 |
| 0.8 | 0.414704 | 0.251469 | 0.585296 | 0.163235 |
| 1.0 | 0.378803 | 0.185206 | 0.621197 | 0.193597 |
| 1.2 | 0.354314 | 0.137179 | 0.645686 | 0.217135 |
| 1.4 | 0.337052 | 0.101898 | 0.662948 | 0.235153 |
| 1.6 | 0.324887 | 0.076019 | 0.675113 | 0.248868 |
| 1.8 | 0.316064 | 0.056806 | 0.683936 | 0.259258 |
| 2.0 | 0.309589 | 0.042479 | 0.690411 | 0.267110 |

**Вариант 8**

Схема превращений:

Начальные концентрации:

|  |  |  |  |
| --- | --- | --- | --- |
| C12H22 | H2 | C12H24 | C12H26 |
| 1.0 | 1.0 | 0.0 | 0.0 |

Время процесса 5.0 сек.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Время, сек. | C12H22 | H2 | C12H24 | C12H26 |
| 0.0 | 1.000000 | 1.000000 | 0.000000 | 0.000000 |
| 0.5 | 0.665902 | 0.654457 | 0.334098 | 0.011445 |
| 1.0 | 0.503057 | 0.473067 | 0.496943 | 0.029989 |
| 1.5 | 0.408516 | 0.360581 | 0.591484 | 0.047935 |
| 2.0 | 0.347671 | 0.283877 | 0.652329 | 0.063794 |
| 2.5 | 0.305806 | 0.228351 | 0.694194 | 0.077455 |
| 3.0 | 0.275508 | 0.186403 | 0.724492 | 0.089104 |
| 3.5 | 0.253061 | 0.154019 | 0.746939 | 0.099041 |
| 4.0 | 0.235750 | 0.128253 | 0.764250 | 0.107497 |
| 4.5 | 0.222170 | 0.107470 | 0.777830 | 0.114700 |
| 5.0 | 0.211370 | 0.090523 | 0.788630 | 0.120847 |

**Вариант 9**

Схема превращений:

Начальные концентрации:

|  |  |  |  |
| --- | --- | --- | --- |
| C13H24 | H2 | C13H26 | C13H28 |
| 1.0 | 1.0 | 0.0 | 0.0 |

Время процесса 7.0 сек.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Время, сек. | C13H24 | H2 | C13H26 | C13H28 |
| 0.0 | 1.000000 | 1.000000 | 0.000000 | 0.000000 |
| 0.7 | 0.563702 | 0.544217 | 0.436298 | 0.019484 |
| 1.4 | 0.399780 | 0.354730 | 0.600220 | 0.045050 |
| 2.1 | 0.316720 | 0.250292 | 0.683280 | 0.066428 |
| 2.8 | 0.267583 | 0.184199 | 0.732417 | 0.083384 |
| 3.5 | 0.236122 | 0.139353 | 0.763878 | 0.096770 |
| 4.2 | 0.214481 | 0.107151 | 0.785519 | 0.107330 |
| 4.9 | 0.199243 | 0.083539 | 0.800757 | 0.115704 |
| 5.6 | 0.188011 | 0.065645 | 0.811989 | 0.122366 |
| 6.3 | 0.179588 | 0.051909 | 0.820412 | 0.127680 |
| 7.0 | 0.173187 | 0.041258 | 0.826813 | 0.131929 |

**Вариант 10**

Схема превращений:

Начальные концентрации:

|  |  |  |  |
| --- | --- | --- | --- |
| C6H6 | C9H18 | C6H5(C9H19) | C6H5(C9H19)2 |
| 1.0 | 1.0 | 0.0 | 0.0 |

Время процесса 1.0 сек.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Время, сек. | C6H6 | C9H18 | C6H5(C9H19) | C6H5(C9H19)2 |
| 0.0 | 1.000000 | 1.000000 | 0.000000 | 0.000000 |
| 0.1 | 0.763925 | 0.741056 | 0.236075 | 0.022868 |
| 0.2 | 0.625082 | 0.559048 | 0.374918 | 0.066034 |
| 0.3 | 0.536538 | 0.426118 | 0.463462 | 0.110421 |
| 0.4 | 0.477625 | 0.327183 | 0.522375 | 0.150441 |
| 0.5 | 0.436645 | 0.252365 | 0.563355 | 0.184279 |
| 0.6 | 0.407310 | 0.195235 | 0.592690 | 0.212075 |
| 0.7 | 0.386167 | 0.151544 | 0.613833 | 0.234623 |
| 0.8 | 0.370454 | 0.117815 | 0.629546 | 0.252640 |
| 0.9 | 0.358605 | 0.091668 | 0.641395 | 0.266937 |
| 1.0 | 0.349649 | 0.071403 | 0.650351 | 0.278246 |

**Вариант 11**

Схема превращений:

Начальные концентрации:

|  |  |  |  |
| --- | --- | --- | --- |
| C6H6 | C10H20 | C6H5(C10H20) | C6H5(C10H20)2 |
| 1.0 | 1.0 | 0.0 | 0.0 |

Время процесса 2.0 сек.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Время, сек. | C6H6 | C10H20 | C6H5(C10H20) | C6H5(C10H20)2 |
| 0.0 | 1.000000 | 1.000000 | 0.000000 | 0.000000 |
| 0.2 | 0.645150 | 0.582859 | 0.354850 | 0.062291 |
| 0.4 | 0.497441 | 0.351402 | 0.502559 | 0.146040 |
| 0.6 | 0.424809 | 0.215116 | 0.575191 | 0.209693 |
| 0.8 | 0.385703 | 0.132838 | 0.614297 | 0.252865 |
| 1.0 | 0.363173 | 0.082268 | 0.636827 | 0.280905 |
| 1.2 | 0.349978 | 0.051198 | 0.650022 | 0.298779 |
| 1.4 | 0.341932 | 0.031831 | 0.658068 | 0.310101 |
| 1.6 | 0.337052 | 0.019860 | 0.662948 | 0.317192 |
| 1.8 | 0.334028 | 0.012378 | 0.665972 | 0.321650 |
| 2.0 | 0.332158 | 0.007721 | 0.667842 | 0.324437 |

**Вариант 12**

Схема превращений:

Начальные концентрации:

|  |  |  |  |
| --- | --- | --- | --- |
| C6H6 | C11H22 | C6H5(C11H23) | C6H5(C11H23)2 |
| 1.0 | 1.0 | 0.0 | 0.0 |

Время процесса 3.0 сек.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Время, сек. | C6H6 | C11H22 | C6H5(C11H23) | C6H5(C11H23)2 |
| 0.0 | 1.000000 | 1.000000 | 0.000000 | 0.000000 |
| 0.3 | 0.700908 | 0.662055 | 0.299092 | 0.038853 |
| 0.6 | 0.552291 | 0.451114 | 0.447709 | 0.101177 |
| 0.9 | 0.469018 | 0.312091 | 0.530982 | 0.156928 |
| 1.2 | 0.418473 | 0.217687 | 0.581527 | 0.200786 |
| 1.5 | 0.386604 | 0.152793 | 0.613396 | 0.233811 |
| 1.8 | 0.365604 | 0.107578 | 0.634396 | 0.258026 |
| 2.1 | 0.351441 | 0.075876 | 0.648559 | 0.275565 |
| 2.4 | 0.341877 | 0.053712 | 0.658123 | 0.288165 |
| 2.7 | 0.335195 | 0.038001 | 0.664805 | 0.297194 |
| 3.0 | 0.330544 | 0.026908 | 0.669456 | 0.303636 |

**Вариант 13**

Схема превращений:

Начальные концентрации:

|  |  |  |  |
| --- | --- | --- | --- |
| C10H22 | C10H20 | C10H18 | H2 |
| 1.0 | 0.0 | 0.0 | 0.0 |

Время процесса 3.0 сек.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Время, сек. | C10H22 | C10H20 | C10H18 | H2 |
| 0.0 | 1.000000 | 0.000000 | 0.000000 | 0.000000 |
| 0.3 | 0.798512 | 0.196856 | 0.004631 | 0.206119 |
| 0.6 | 0.637629 | 0.345377 | 0.016993 | 0.379364 |
| 0.9 | 0.509125 | 0.455738 | 0.035136 | 0.526011 |
| 1.2 | 0.406554 | 0.535895 | 0.057551 | 0.650996 |
| 1.5 | 0.324666 | 0.592312 | 0.083021 | 0.758355 |
| 1.8 | 0.259172 | 0.630259 | 0.110569 | 0.851397 |
| 2.1 | 0.206936 | 0.653567 | 0.139498 | 0.932562 |
| 2.4 | 0.165324 | 0.665440 | 0.169236 | 1.003911 |
| 2.7 | 0.132049 | 0.668659 | 0.199291 | 1.067242 |
| 3.0 | 0.105444 | 0.665231 | 0.229326 | 1.123882 |

**Вариант 14**

Схема превращений:

Начальные концентрации:

|  |  |  |  |
| --- | --- | --- | --- |
| C11H24 | C11H22 | C11H20 | H2 |
| 0.8 | 0.1 | 0.1 | 0.0 |

Время процесса 4.0 сек.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Время, сек. | C11H24 | C11H22 | C11H20 | H2 |
| 0.0 | 0.800000 | 0.100000 | 0.100000 | 0.000000 |
| 0.4 | 0.592651 | 0.233285 | 0.174063 | 0.281412 |
| 0.8 | 0.439050 | 0.277354 | 0.283596 | 0.544545 |
| 1.2 | 0.325249 | 0.274252 | 0.400500 | 0.775251 |
| 1.6 | 0.240959 | 0.248230 | 0.510811 | 0.969852 |
| 2.0 | 0.178496 | 0.213638 | 0.607866 | 1.129369 |
| 2.4 | 0.132246 | 0.177654 | 0.690099 | 1.257853 |
| 2.8 | 0.097956 | 0.144498 | 0.757546 | 1.359590 |
| 3.2 | 0.072582 | 0.115378 | 0.812039 | 1.439457 |
| 3.6 | 0.053772 | 0.090998 | 0.855230 | 1.501459 |
| 4.0 | 0.039836 | 0.071047 | 0.889116 | 1.549280 |

**Вариант 15**

Схема превращений:

Начальные концентрации:

|  |  |  |  |
| --- | --- | --- | --- |
| C12H26 | C12H24 | C12H22 | H2 |
| 1.0 | 0.0 | 0.0 | 0.0 |

Время процесса 2.5 сек.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Время, сек. | C12H26 | C12H24 | C12H22 | H2 |
| 0.00 | 1.000000 | 0.000000 | 0.000000 | 0.000000 |
| 0.25 | 0.769126 | 0.179279 | 0.051594 | 0.282468 |
| 0.50 | 0.591555 | 0.246087 | 0.162357 | 0.570802 |
| 0.75 | 0.454978 | 0.254623 | 0.290399 | 0.835421 |
| 1.00 | 0.349938 | 0.235179 | 0.414883 | 1.064945 |
| 1.25 | 0.269144 | 0.204706 | 0.526150 | 1.257006 |
| 1.50 | 0.207007 | 0.171754 | 0.621239 | 1.414232 |
| 1.75 | 0.159211 | 0.140799 | 0.699989 | 1.540778 |
| 2.00 | 0.122460 | 0.113448 | 0.764092 | 1.641632 |
| 2.25 | 0.094184 | 0.090438 | 0.815378 | 1.721194 |
| 2.50 | 0.072444 | 0.071441 | 0.856116 | 1.783672 |

**Вариант 16**

Схема превращений:

Начальные концентрации:

|  |  |  |  |
| --- | --- | --- | --- |
| C13H28 | C13H26 | C13H24 | H2 |
| 1.0 | 0.0 | 0.0 | 0.0 |

Время процесса 3.0 сек.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Время, сек. | C13H28 | C13H26 | C13H24 | H2 |
| 0.0 | 1.000000 | 0.000000 | 0.000000 | 0.000000 |
| 0.3 | 0.509126 | 0.451887 | 0.038987 | 0.529861 |
| 0.6 | 0.259169 | 0.618828 | 0.122003 | 0.862834 |
| 0.9 | 0.132030 | 0.649323 | 0.218647 | 1.086618 |
| 1.2 | 0.067244 | 0.618173 | 0.314583 | 1.247338 |
| 1.5 | 0.034223 | 0.562150 | 0.403627 | 1.369403 |
| 1.8 | 0.017459 | 0.498976 | 0.483564 | 1.466105 |
| 2.1 | 0.008898 | 0.437094 | 0.554008 | 1.545111 |
| 2.4 | 0.004528 | 0.380008 | 0.615464 | 1.610936 |
| 2.7 | 0.002311 | 0.328919 | 0.668770 | 1.666460 |
| 3.0 | 0.001177 | 0.283976 | 0.714846 | 1.713669 |

**Вариант 17**

Схема превращений:

Начальные концентрации:

|  |  |  |  |
| --- | --- | --- | --- |
| C9H16 | H2 | C9H18 | C9H20 |
| 1.0 | 1.0 | 0.0 | 0.0 |

Время процесса 2.0 сек.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Время, сек. | C9H16 | H2 | C9H18 | C9H20 |
| 0.0 | 1.000000 | 1.000000 | 0.000000 | 0.000000 |
| 0.2 | 0.803123 | 0.757841 | 0.196877 | 0.045282 |
| 0.4 | 0.682473 | 0.551843 | 0.317527 | 0.130631 |
| 0.6 | 0.606924 | 0.392091 | 0.393076 | 0.214833 |
| 0.8 | 0.558928 | 0.274084 | 0.441072 | 0.284845 |
| 1.0 | 0.528232 | 0.189702 | 0.471768 | 0.338529 |
| 1.2 | 0.507657 | 0.130401 | 0.492343 | 0.377257 |
| 1.4 | 0.494112 | 0.089270 | 0.505888 | 0.404842 |
| 1.6 | 0.485231 | 0.061124 | 0.514769 | 0.424108 |
| 1.8 | 0.479111 | 0.041679 | 0.520889 | 0.437432 |
| 2.0 | 0.474987 | 0.028393 | 0.525013 | 0.446594 |

**Вариант 18**

Схема превращений:

Начальные концентрации:

|  |  |  |  |
| --- | --- | --- | --- |
| C10H18 | H2 | C10H20 | C10H22 |
| 1.0 | 1.0 | 0.0 | 0.0 |

Время процесса 3.5 сек.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Время, сек. | C10H18 | H2 | C10H20 | C10H22 |
| 0.00 | 1.000000 | 1.000000 | 0.000000 | 0.000000 |
| 0.35 | 0.670272 | 0.612449 | 0.329728 | 0.057823 |
| 0.70 | 0.523322 | 0.382761 | 0.476678 | 0.140561 |
| 1.05 | 0.448252 | 0.241638 | 0.551748 | 0.206614 |
| 1.40 | 0.406220 | 0.153228 | 0.593780 | 0.252991 |
| 1.75 | 0.381779 | 0.097568 | 0.618221 | 0.284211 |
| 2.10 | 0.366855 | 0.062144 | 0.633145 | 0.304711 |
| 2.45 | 0.357728 | 0.039719 | 0.642272 | 0.318009 |
| 2.80 | 0.351954 | 0.025330 | 0.648046 | 0.326624 |
| 3.15 | 0.348351 | 0.016215 | 0.651649 | 0.332135 |
| 3.50 | 0.346048 | 0.010360 | 0.653952 | 0.335688 |

**Вариант 19**

Схема превращений:

Начальные концентрации:

|  |  |  |  |
| --- | --- | --- | --- |
| C11H20 | H2 | C11H22 | C11H24 |
| 1.0 | 1.0 | 0.0 | 0.0 |

Время процесса 2.2 сек.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Время, сек. | C11H20 | H2 | C11H22 | C11H24 |
| 0.00 | 1.000000 | 1.000000 | 0.000000 | 0.000000 |
| 0.22 | 0.661916 | 0.624390 | 0.338084 | 0.037526 |
| 0.44 | 0.507416 | 0.413866 | 0.492584 | 0.093550 |
| 0.66 | 0.424397 | 0.282610 | 0.575603 | 0.141786 |
| 0.88 | 0.375270 | 0.196227 | 0.624730 | 0.179043 |
| 1.10 | 0.344417 | 0.137642 | 0.655583 | 0.206774 |
| 1.32 | 0.324187 | 0.097138 | 0.675813 | 0.227049 |
| 1.54 | 0.310717 | 0.068959 | 0.689283 | 0.241759 |
| 1.76 | 0.301372 | 0.048985 | 0.698628 | 0.252387 |
| 1.98 | 0.294943 | 0.034921 | 0.705057 | 0.260022 |
| 2.20 | 0.290450 | 0.024947 | 0.709550 | 0.265503 |

**Вариант 20**

Схема превращений:

Начальные концентрации:

|  |  |  |  |
| --- | --- | --- | --- |
| C12H22 | H2 | C12H24 | C12H26 |
| 1.0 | 1.0 | 0.0 | 0.0 |

Время процесса 4.0 сек.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Время, сек. | C12H22 | H2 | C12H24 | C12H26 |
| 0.0 | 1.000000 | 1.000000 | 0.000000 | 0.000000 |
| 0.4 | 0.717886 | 0.661361 | 0.282114 | 0.056525 |
| 0.8 | 0.577508 | 0.432155 | 0.422492 | 0.145353 |
| 1.2 | 0.501314 | 0.280583 | 0.498686 | 0.220730 |
| 1.6 | 0.457640 | 0.181602 | 0.542360 | 0.276037 |
| 2.0 | 0.431250 | 0.117227 | 0.568750 | 0.314023 |
| 2.4 | 0.415212 | 0.075719 | 0.584788 | 0.339493 |
| 2.8 | 0.405036 | 0.048752 | 0.594964 | 0.356284 |
| 3.2 | 0.398686 | 0.031476 | 0.601314 | 0.367210 |
| 3.6 | 0.394604 | 0.020267 | 0.605396 | 0.374337 |
| 4.0 | 0.392003 | 0.013059 | 0.607997 | 0.378944 |

**Вариант 21**

Схема превращений:

Начальные концентрации:

|  |  |  |  |
| --- | --- | --- | --- |
| C13H24 | H2 | C13H26 | C13H28 |
| 1.0 | 1.0 | 0.0 | 0.0 |

Время процесса 3.0 сек.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Время, сек. | C13H24 | H2 | C13H26 | C13H28 |
| 0.0 | 1.000000 | 1.000000 | 0.000000 | 0.000000 |
| 0.3 | 0.683786 | 0.648352 | 0.316214 | 0.035434 |
| 0.6 | 0.531328 | 0.440390 | 0.468672 | 0.090938 |
| 0.9 | 0.446887 | 0.306498 | 0.553113 | 0.140390 |
| 1.2 | 0.395606 | 0.216132 | 0.604394 | 0.179474 |
| 1.5 | 0.363170 | 0.153919 | 0.636830 | 0.209251 |
| 1.8 | 0.341429 | 0.110057 | 0.658571 | 0.231371 |
| 2.1 | 0.326779 | 0.079097 | 0.673221 | 0.247682 |
| 2.4 | 0.316631 | 0.057003 | 0.683369 | 0.259628 |
| 2.7 | 0.309460 | 0.041111 | 0.690540 | 0.268350 |
| 3.0 | 0.304397 | 0.029703 | 0.695603 | 0.274694 |

**Вариант 22**

Схема превращений:

Начальные концентрации:

|  |  |  |  |
| --- | --- | --- | --- |
| C6H6 | C9H18 | C6H5(C9H19) | C6H5(C9H19)2 |
| 1.0 | 1.0 | 0.0 | 0.0 |

Время процесса 2.2 сек.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Время, сек. | C6H6 | C9H18 | C6H5(C9H19) | C6H5(C9H19)2 |
| 0.00 | 1.000000 | 1.000000 | 0.000000 | 0.000000 |
| 0.22 | 0.657937 | 0.615086 | 0.342063 | 0.042851 |
| 0.44 | 0.504814 | 0.399443 | 0.495186 | 0.105371 |
| 0.66 | 0.424115 | 0.266366 | 0.575885 | 0.157749 |
| 0.88 | 0.377325 | 0.180258 | 0.622675 | 0.197067 |
| 1.10 | 0.348482 | 0.123021 | 0.651518 | 0.225461 |
| 1.32 | 0.330020 | 0.084418 | 0.669980 | 0.245602 |
| 1.54 | 0.317965 | 0.058200 | 0.682035 | 0.259765 |
| 1.76 | 0.309821 | 0.040131 | 0.690179 | 0.269690 |
| 1.98 | 0.304375 | 0.027787 | 0.695625 | 0.276588 |
| 2.20 | 0.300640 | 0.019240 | 0.699360 | 0.281401 |

**Вариант 23**

Схема превращений:

Начальные концентрации:

|  |  |  |  |
| --- | --- | --- | --- |
| C6H6 | C10H20 | C6H5(C10H20) | C6H5(C10H20)2 |
| 1.0 | 1.0 | 0.0 | 0.0 |

Время процесса 1.5 сек.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Время, сек. | C6H6 | C10H20 | C6H5(C10H20) | C6H5(C10H20)2 |
| 0.00 | 1.000000 | 1.000000 | 0.000000 | 0.000000 |
| 0.15 | 0.734148 | 0.701657 | 0.265852 | 0.032492 |
| 0.30 | 0.590352 | 0.501295 | 0.409648 | 0.089057 |
| 0.45 | 0.504508 | 0.361633 | 0.495492 | 0.142876 |
| 0.60 | 0.450573 | 0.262621 | 0.549427 | 0.187952 |
| 0.75 | 0.414720 | 0.191316 | 0.585280 | 0.223404 |
| 0.90 | 0.390640 | 0.139905 | 0.609360 | 0.250735 |
| 1.05 | 0.373826 | 0.102445 | 0.626174 | 0.271381 |
| 1.20 | 0.361901 | 0.075046 | 0.638099 | 0.286854 |
| 1.35 | 0.353495 | 0.055128 | 0.646505 | 0.298367 |
| 1.50 | 0.347418 | 0.040504 | 0.652582 | 0.306914 |