$$C_6H_5CH_3 \xrightarrow{k_1} C_6H_5CH_2 + H; \quad \text{(start of a chain*)}$$

$$H + C_6H_5CH_3 \xrightarrow{k_2} C_6H_5CH_2 + H_2;$$

$$\left|\begin{array}{l} \xrightarrow{k_3} C_6H_4CH_3 + H_2; \\ \xrightarrow{k_4} C_6H_6 + CH_3; \\ \xrightarrow{k_5} C_6H_5 + CH_4. \end{array}\right.$$

$$H_2 + C_6H_5CH_2 \xrightarrow{k_6} C_6H_5CH_3 + H; \quad H_2 + C_6H_4CH_3 \xrightarrow{k_7} C_6H_5CH_3 + H;$$

$$H_2 + CH_3 \xrightarrow{k_8} CH_4 + H; \quad H_2 + C_6H_5 \xrightarrow{k_9} C_6H_6 + H;$$

$$C_6H_5CH_3 + C_6H_4CH_3 \xrightarrow{k_{10}} C_6H_5CH_2 + C_6H_5CH_3;$$

$$C_6H_5CH_3 + CH_3 \xrightarrow{k_{11}} C_6H_5CH_2 + CH_4;$$

$$C_6H_5CH_3 + C_6H_5 \xrightarrow{k_{12}} C_6H_5CH_2 + C_6H_6;$$

$$H + CH_4 \xrightarrow{k_{13}} CH_3 + H_2; \quad H + C_6H_6 \xrightarrow{k_{14}} C_6H_5 + H_2;$$

$$2C_6H_5 \xrightarrow{k_{15}} (C_6H_5)_2; \quad 2C_6H_5CH_2 \xrightarrow{k_{16}} (C_6H_5CH_2)_2;$$

$$2C_6H_4CH_3 \xrightarrow{k_{17}} (C_6H_4CH_3)_2; \quad 2CH_3 \xrightarrow{k_{18}} C_2H_6.$$

Certain "cross-reactions" might also be added, leading to the formation of ethylbenzene, xylene, methydiphenyl, diphenylmethane and other products. Among the reaction products are ethane [29, 30]. As for dibenzyl, obtained by some workers [31], it was shown [29] that under the experimental conditions it underwent destructive hydrogenation.

If it is assumed that most reaction chains end on tolyl radicals, analysis of the above scheme of reaction leads to the following formula for the rate of production of benzene, w:

$$w = \sqrt{\frac{k_1}{k_{17}}} \frac{(k_4 + k_5)}{k_3} (H_2) \sqrt{(C_6H_5CH_3)} \left[k_7 + k_{10} \frac{(C_6H_5CH_3)}{(H_2)} \right]. \qquad \text{(VIII)}$$

Similar formulae may also be obtained by assuming that most reaction chains end on methyl or phenyl (but not benzyl) radicals.

Comparison of equation (VIII) with the experimental results given in ref. [29] (see above) shows that this equation is in qualitative agreement with the experimental data.

Investigation of the destructive hydrogenation of toluene under high pressure thus enables us to put forward a scheme for a chain mechanism for this process, which can be used to derive an expression for the reaction velocity in qualitative agreement with the experimental results.

A very interesting investigation has also been made of the homogeneous destructive hydrogenation of ethylbenzene [28]. The ratio of benzene to toluene increases rapidly with the partial pressure of hydrogen (see figure on next page).

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* Reaction (1') (see above) can also initiate a reaction chain.