Scheme 2. *Synthesis of hydroxypropargylamides 7 and 10 using Ugi reaction*
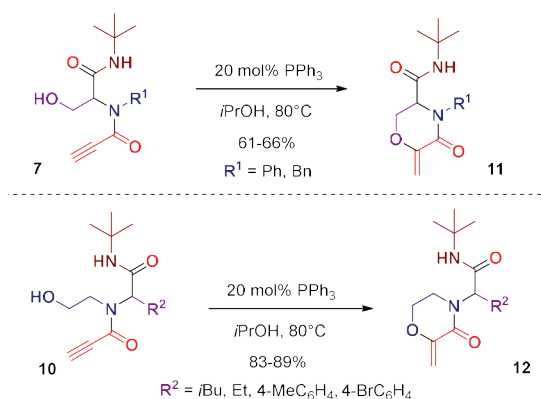

Scheme 3. *Synthesis of morpholines 11 and 12 through the PPh₃-catalyzed intramolecular umpolung oxa-Michael addition*

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CATALYTIC CRACKING FEEDSTOCK COMPOSITION AND PROPERTIES INVESTIGATION FOR THE PROCESS DIGITAL TWIN DEVELOPMENT PURPOSE

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At present, both in Russian and in the world oil refining, the volume of heavy highly viscous feedstock is increasing. It is and contains a large amount of sulfur compounds. As a result, processes that allows the efficient heavy oil feedstock processing come to the fore. One of these processes is catalytic cracking [1].

Today, the most common type of catalytic cracking is a continuous fluidized bed process [2]. The most common unit type is riser reactor with regenerator. The development of highly efficient

cracking catalysts, along with the modernization of the technological process, as well as the process conditions optimization, provided a significant increase in the yield and quality improvement of the desired products. However, despite the progress made in improving catalytic cracking technology, there are a number of unresolved problems [1–2].

In the course of cracking reactions, a variety of substances are formed, including coke, a solid residue consisting mostly of carbon, which accumulates on the surface of the catalyst, and the so-called coking occurs. The formation of a coke layer on the catalyst leads to a significant decrease in its activity, and regeneration of the catalyst becomes necessary. Coking and catalyst activity decrease are among the most significant problems encountered during catalytic cracking units operation. These phenomena are promoted by certain groups of substances in the feedstock composition, in particular, the presence of polycyclic aromatics and resinous compounds under cracking conditions lead to a decrease in gasoline yield and an increase in heavy fractions and coke formation [3]. The presence of coking promoting components may be indirectly identified by the values of density and molecular weight, but complete information is provided by direct study of the sample group composition. Feedstock group composition analysis is a very important task, since these data are widely used in predictive calculations of the products yield and composition, in the process optimization, as well as in the direct control of the plant operation. The results of this work will be used in catalytic cracking process digital twin development.

The main aim of this work was to determine the group composition of the catalytic cracking feedstock and obtain paraffinic fractions to carry out the urea reaction.

Table 1 shows the catalytic cracking feedstock group composition analysis results obtained by the means of liquid adsorption chromatography method.

Paraffinic hydrocarbons content in the catalytic cracking feedstock vary in the range from 56.80 to 61.57 wt. %, aromatic hydrocarbons content lays within the range of 35.42–40.46 wt. %, resinous components content is 2.36–3.01 wt. %.

The paraffinic fraction is further separated into iso-alkanes and n-alkanes in the urea reaction. Separated and dried to constant weight n-alkanes are sent to GC-MS analysis to determine hydrocarbons chain length distribution.

The results presented in this work will be used in the future to develop the model of the coupled system "lift-reactor-regenerator".

Table 1. Liquid Adsorption Chromatography Results

Feed №1, % wt.			Feed №2, % wt.			Feed №3, % wt.		
P	A	R	P	A	R	P	A	R
61.57	35.42	3.01	57.71	39.93	2.36	56.80	40.46	2.73

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