INNOVATIVE TECHNOLOGY DEVELOPMENT

KMG Engineering

KMG Engineering LLP is a scientific research centre of JSC NC KazMunayGas. It was founded in 2014 to provide comprehensive scientific and engineering support for exploration, production, and drilling of KMG's hydrocarbon resources. The Research and Development Institute of Production and Drilling Technology has its head office in Nur-Sultan and two branches, Atyrau Branch LLP in Atyrau and KazNIPImunaygas LLP in Aktau, which provide direct real-time support for KMG's assets.

Objectives of KMG Engineering LLP and its branches:

- increase production profitability
- expand reserves and resource base
- improve production and programme efficiency.

To achieve these objective, KMG Engineering LLP develops and implements competitive technologies and procedures conventional for the global industry, provides expert support to the use of these technologies and procedures across KMG's fields portfolio.

2021 results

KMG has 112 hydrocarbon fields, including 81 fields under active development. To achieve the production targets at these fields, the work of KMG Engineering covers five key areas:

- exploration
- production
- major projects
- surface facilities
- well drilling, servicing, and workover.

Exploration

In 2021, KMG Engineering LLP carried out a comprehensive analysis of geological and geophysical data of the exploration and production projects to unlock the potential for expanding the resource base, supported the Regional Survey Programme, performed the amplitude analysis of seismic data, and assessed oil and gas assets under M&A.

KMG Engineering LLP developed the detailed further exploration programme for the Karazhanbas field (JSC Karazhanbasmunai) and updated the follow-up data of the approved detailed further exploration programmes for JSC Ozenmunaigas, JSC Mangistaumunaigaz, JSC Embamunaigas, and Kazakhturkmunay LLP, which included support in 2D/3D seismic data processing and interpretation as well as support in coring and development well testing.

Successful implementation of exploration and production projects requires timely acquisition of up-to-date information and integrated use of reams of historical, geological, geophysical, and field data. KMG Engineering LLC has implemented the Centralised Database information system to ensure efficient centralised management of information systems containing large volumes of data.

Production

The institute piloted advanced drilling technologies: horizontal wells, horizontal wells with multi-stage fracturing, side-tracking, and deepening, which resulted in a considerable oil output growth at a lower cost. It is expected that drilling cost optimisation (replacement of vertical wells with side-tracking and deepening) will ensure CAPEX savings while maintaining the efficiency.

The use of general standard criteria, including comprehensive ranking based on profitability, improves the selection of well intervention measures resulting in higher output at a lower cost.

Corrosion monitoring and infrastructure integrity are among the major challenges for KMG's mature fields. The new recently implemented technologies include injection of bactericides to prevent biological contamination of reservoirs, injection of corrosion and scale inhibitors at suction pumps in producing wells, use of submerged motor pumps and production tubing with protective coating. These measures resulted in positive technical and economic effect and extended the run time of the subsurface pumping equipment meaning more oil output at less cost.

Development and implementation of optimal well intervention measures to increase production at Kazakhturkmunay LLP is a remarkable example of the production unit's successful operations. The expenses were recouped within five months. The use of advanced technologies will maintain the achieved production level within five years. It is planned to replicate this successful practice at other KMG's fields.

Major projects

KMG Engineering LLP activities include R&D support for offshore projects (Kashagan, Kairan, Aktoty) and onshore projects of Tengizchevroil LLP (Tengiz, Korolevskoye) and Karachaganak Petroleum Operating B.V. (Karachaganak).

Participation of technical specialists from the Company's major project unit in working groups and technical meetings with the project partners – North Caspian Operating Company, Tengizchevroil LLP, and Petroleum Operating B.V. – results in high-quality review of the development projects and cost optimisation, generating greater value for KMG from these strategic assets.

- Tengizchevroil: drilling of 55 directional wells under the Future Growth Project / Wellhead Pressure Management Project. The project on Alb-Cenomanian water injection for reservoir pressure maintenance at the Korolevskoye field was completed. Trial water injection of 15,000 bbl per day was commenced. Design of ethane separation from Tengizchevroil's commercial gas with further supply of ethane to KLPE was completed.
- Karachaganak: the fourth compressor is under start-up. KEP-1A, 1B projects are underway. Additional drilling of 6–8 wells as part of the project will maintain the production plateau.
- Kashagan: VSMA 1 project to increase productivity from 400,000 to 450,000 bbl per day, including construction of a gas processing plant with a capacity of 1 bln m^3 per year by JSC NC QazaqGaz. The concept of productivity increase to 1 mln bbl per day is under development. Previously made artificial islands are used for drilling. Bolashak waste water treatment project is underway.

Well drilling and workover

KMG Engineering LLP has the Online Drilling Competence Centre in place to monitor drilling and render geological and engineering support in real time. Implementation of an integrated drilling reporting system is also underway.

Drilling of new wells is one of the main ways to sustain oil production at the mature fields of KMG's subsidiaries and associates. In addition to vertical wells, the amount of horizontal wells drilled every year is increasing. The key advantages of horizontal wells include reduced total amount of wells at the fields, increased oil recovery, development of new oil reservoirs and high-viscosity oil.

In 2021, the average reservoir penetration by 16 horizontal wells was 86%. The horizontal well rates are on average three to four times higher tha vertical well rates at the same fields of KMG's subsidiaries and associates.

The works conducted at KMG's subsidiaries and associates resulted in the cementing strength of completed

well production strings of 72% in 2019–2021 compared to 67% in 2017–2018.

Well workover is the key to operability of the well stock. Its efficiency is analysed by types of workovers. Well-work instructions are being developed to define the common procedure and technical requirements. Continued efforts are taken to identify and implement advanced technologies to eliminate casing pressure and perform remedial cementing.

In 2021, regulations to monitor, control, and eliminate casing pressure in wells at the fields of KMG's subsidiaries and associates were developed. The technology eliminating casing pressure using Aquascreen synthetic compound was piloted.

Surface facilities and infrastructure

To extend the field production life and keep the process control systems up to date, KMG Engineering LLP opened the Surface Facilities Unit dealing with infrastructure integrity, reliability, and optimisation.

Production automation and hydrocarbon metering system optimisation

Particular attention is paid to implementation of advanced automation and digitalisation systems as part of optimising oil and gas condensate metering systems of JSC NC KazMunayGas production assets. Automated control systems are gradually updated and modern measuring equipment is installed at all stages of oil and gas production, from a well to the delivery of hydrocarbons to the pipeline system. To ensure compliance with ST RK 2.151-2008 Metering of Extracted Oil and Oil Gas, measures are taken to improve the metering system by replacing volumetric oil flow meters with Coriolis flow meters (mass meters) measuring two phases of liquid.

Another important area includes scientific and methodological support provided by KMG Engineering LLP. Its staff carries out technical inspections of subsidiaries' and associates' production facilities to check the instruments and controls used. The results of such inspections make it possible to analyse the current state of automated oil, gas, and water metering systems and equipment, check compliance

with the regulations of the Republic of Kazakhstan in terms of measurement uniformity, and define recommended measures for JSC NC KazMunayGas production assets to be included in action plans.

For example, JSC Mangistaumunaigaz has been renovating telemechanics systems at its production facilities since 2019. Since 2021, Kazakhturkmunay LLP has been implementing the process automation system at its production facilities and remote control systems for wells at Karatobe South, Laktybai and a head pump station at Kenkiyak.

To improve metering quality and accuracy of outdated metering stations as well as to standardise the equipment, JSC Ozenmunaigas, JSC Mangistaumunaigaz, JSC Embamunaigas, JSC Karazhanbasmunai, and Kazakhoil Aktobe LLP are gradually upgrading and replacing the metering system of group units and automated group metering stations.

To comply with the Kazakhstan's Code on Subsoil and Subsoil Use, an Information System of Crude Oil and Gas Condensate Metering for automated daily collection, processing and storage of data on available crude oil and condensate gas was developed. In 2021, JSC NC KazMunayGas completed the transfer of data from commercial metering stations of seven operating production assets of JSC NC KazMunayGas into the Information System of Crude Oil and Gas Condensate Metering using the ABAI system.

ABAI DATABASE IS AN IN-HOUSE DATA IMPORT AND STORAGE SYSTEM. IT ALSO GENERATES PRODUCTION REPORTS AND ENSURES PROMPT ACCESS TO ALL KMG EXPLORATION AND PRODUCTION DATA