PROJECT NAME: CO_2 EOR Project Croatia

LOCATION: INA E&P

DURATION: 2014 - 2039

TOTAL INVESTMENT: HRK 520 mil. (first phase of the Project)

OUTCOME: Enhanced recovery for 6 % compared to stored oil, prior to production (OOIP); additional production of 360.4 t of oil and 55,120 m^3 of gas; reduced CO_2 emissions permanent disposal of 2.9 billion m^3 CO_2 or 5.4 million tonnes of CO_2

PROJECT DESCRIPTION

1) PROJECT HISTORY

Production of residual hydrocarbons can be done by different tertiary recovery methods. A method largely applied on depleted oil reservoirs is injection of carbon dioxide, called EOR (Enhanced Oil Recovery).

Assessment of possibility of CO_2 injection into Croatian oil fields was carried out during last decades of the 20th century. Examination results singled out the most appropriate fields for applying the method.
Extensive laboratory research determined thermodynamic interaction of the injected CO_2 and reservoir fluid and thus confirmed the effectiveness of the process of oil displacement. The best increase in oil recovery was achieved by alternating water injection and gas (abbr. WAG). Plan is to perform 6 WAG cycles during next 25 years.

During 2001 - 2006, on limited part of the Upper Miocene sandstone oil reservoir of the Ivanić Field, a pilot project of alternating water and CO_2 injection was performed. In the scope of the pilot, which used one injection and two production wells, oil and gas recovery was significantly increased, which justified preparation of the EOR project on the Fields Ivanić and Žutica. The injection of CO_2 in Ivanić oilfield started in October 2014 and northern part of Žutica oilfields in October 2015. Figure 1. shows a typical injection well on Ivanić oilfield.

Figure 1. injection WAG wells on Ivanić oilfield

2) PROJECT BACKGROUND

The EOR project considers dehydration, compression and transmitting of 600,000 m^3/day of CO_2 by gas pipeline (20 in.). The source of CO_2 is at the Gas Processing Facilities Molve from where, after compression and dehydration CO_2 is transported (in gaseous state) by an 88 km long pipeline to the Fractionation Facilities of Ivanić Grad. After its compression and liquefaction, CO_2 is further transported by pipeline at maximum pressure (200 bar) from the Fractionation Facilities of Ivanić Grad to the injection wells of the fields Ivanić and Žutica, in quantities of 600,000 m^3/day.
Figure 2. presents the scheme of the EOR project. Figure 3. shows the new compressor station for CO_2 on GPF Molve.

Figure 2. Scheme of EOR project

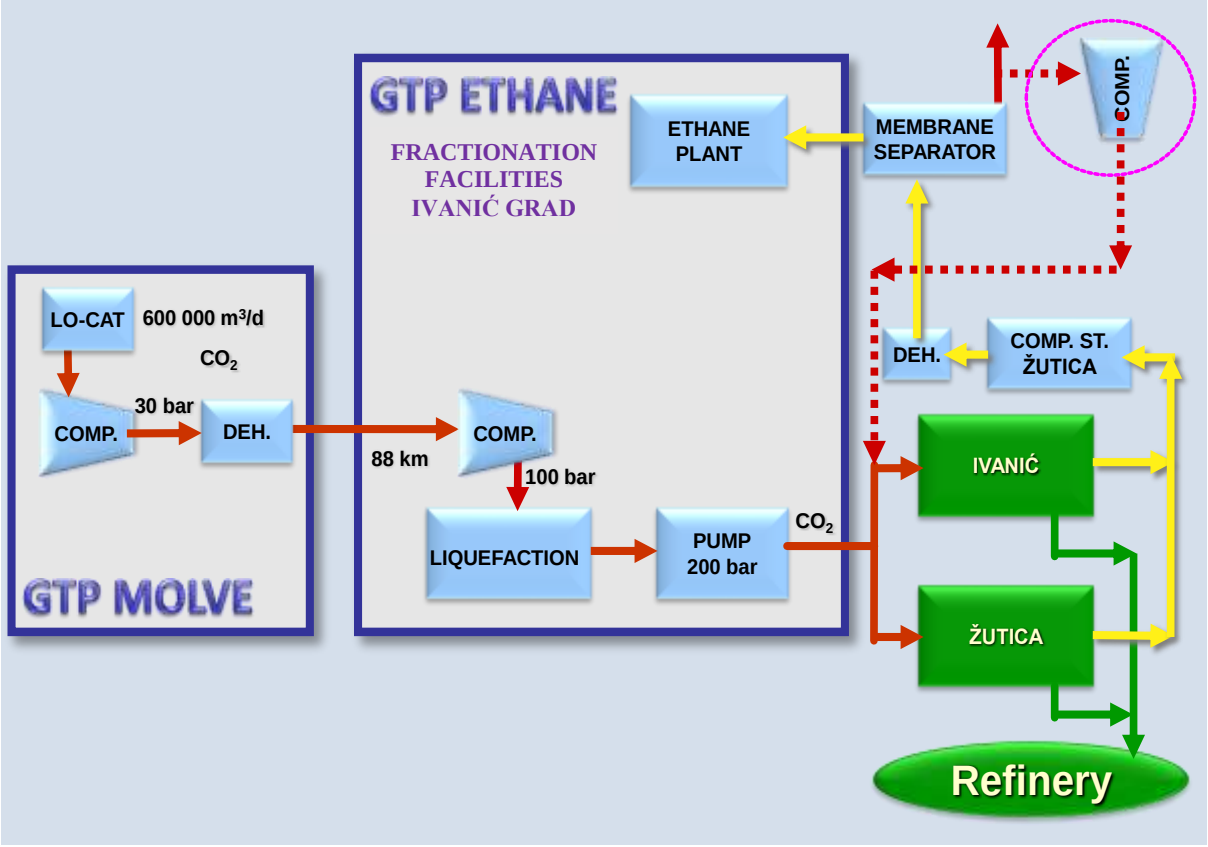


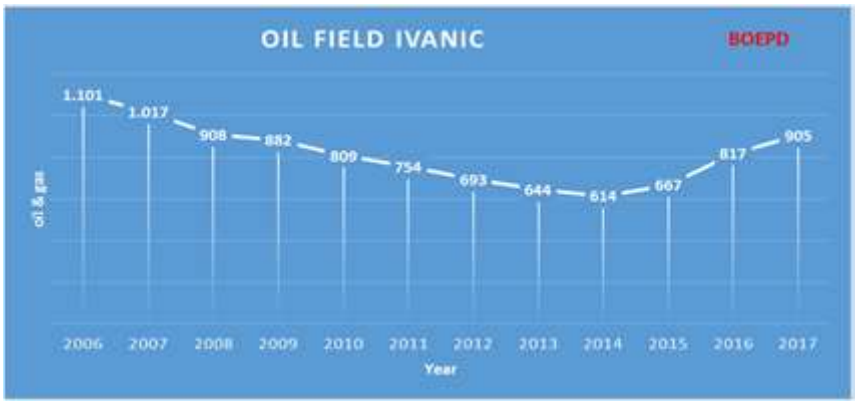
Figure 3. CO_2 Compressor station on GPF Molve

The importance of the project is manifested through increasing economic value of the fields Ivanić and Žutica, by enhancing hydrocarbon recovery for 6 % compared to OOIP; i.e. additional production of 360.4 tonnes of oil and 55,120 m^3 of gas. On the other hand, by application of the EOR project CO_2 emissions will be significantly reduced (permanent disposal of 2.9 billion m^3 CO_2 or 5.4 million tonnes of CO_2), representing a special environmental value of the project.

3) MAIN RESULTS AND OUTCOMES OF THE PROJECT

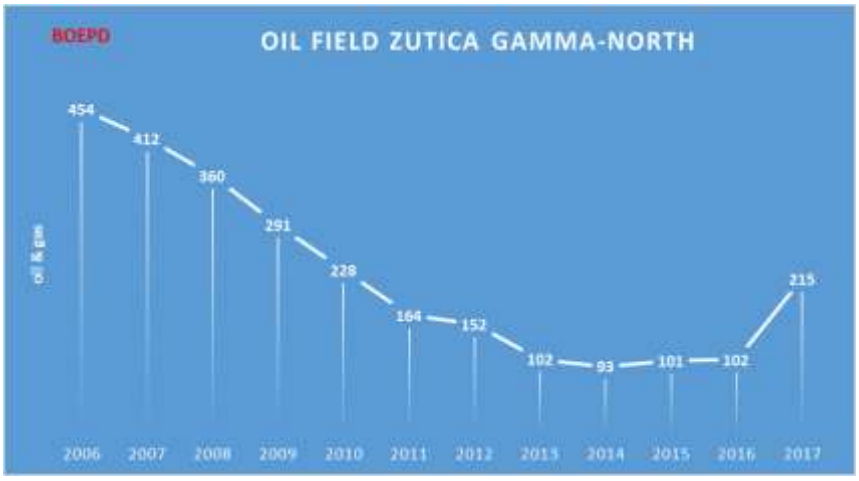
Between 2014-2016 about 323 million m^3 of CO_2 was injected in Ivanić oilfield and more than 93 million m^3 of CO_2 was injected in northern part of Žutica oilfields. After 25 months of CO_2 injection into oil reservoirs, oil and gas response was achieved on 60% of production wells on Ivanić oilfield, and oil and gas production increased by 30%. Figure 4. presents the average daily oil and gas on the Ivanić oilfield.

Figure 4. daily oil and gas production on Ivanić oilfield



Oil and gas response was achieved on 30% of production wells of Žutica North oilfield after 9 months of CO_2 injection. As a result, oil and gas production was increased by more than 100% (Figure 5.).

Figure 5. daily oil and gas production on Žutica North oilfield



4) FURTHER STEPS

The plan is to continue CO_2 injection as part of the first WAG cycles on a fraction of the Ivanić oilfield and on Žutica North until Q4 in 2017. After that CO_2 will be injected into oil reservoirs on the southern part of Žutica oilfields. On the Southern part of the Žutica oilfields, well-relining was completed on 16 CO_2 injection wells, and after finalization of surface facilities and technical inspection, the plan is to start CO_2 injection in 2018.

Process results monitoring of Ivanić and Žutica oilfields is performed on a daily basis.