Characteristics of Hydrocarbon Fields in the Croatian Part of the Pannonian Basin

By J. VELIC, T. MALVIC, M. CVETKOVIC and B. VRBANAC*

Abstract

Approximately 104 x 10^6 m^3 of oil from 39 fields, 6.93 x 10^6 m^3 of condensate (11 fields) and 64.92 x 10^9 m^3 of gas (52 fields) were recovered in the Croatian part of the Pannonian basin during 63 years of exploitation (1941–2004). The total production peak was attained in 1980–1989, when exploitation began in 12 new fields. The longest production period is assumed for the largest fields; for oil it is approximately 55 years, whereas for condensate and gas 46 and 36 years of exploitation are expected, respectively. Water-flooding will probably be the dominant secondary-recovery method for increased production in the future, because CO_2 injection requires transport and analysis of fluid interactions.

Croatia's Pannonian Basin Fields

Four large Neogene and Quaternary geotectonic units, regional structural depressions, are described for the Croatian part of the Pannonian basin system. Generally 30 years (1959–1989) can be described as a highly successful exploration period (Fig. 1a, 1b).

The total (geological) reserves are about 740 x 10^6 m^3 of equivalent oil, with recoverable reserves of 112 x 10^6 m^3 of oil, 10.74 x 10^6 m^3 of condensate and 100.67 x 10^9 m^3 of gas. Up to 2004 a total of 175.89 x 10^6 m^3 of equivalent oil had been recovered from Croatian fields, including 104.05 x 10^6 m^3 of oil from 39 fields, 6.93 x 10^6 m^3 of condensate from 11 fields and 64.91 x 10^9 m^3 of gas from 52 fields [1, 5] (Fig. 1a).

The number of new fields rapidly increased in the sixties for oil and in the eighties for gas (Fig. 1b). This period was followed by a drastic decline in new discoveries. Generally 30 years (1959–1989) can be described as a highly successful exploration period, when potential structural and combined traps could be observed by use of several easily applied methods.

The cause for a rapid decrease in production after 1989 is threefold: depletion of older fields, and consequently a substantial decrease in exploration activities.

The most often used production mechanisms were: (a) for the largest fields, artificial lift and gas lift, rarely flowing; (b) for medium fields, artificial lift; (c) for small fields, artificial and gas lifts. The most applied secondary recovery method for many fields is water injection.

For the largest oil fields, reservoirs are sandstones of Pannonian and Pontian age, mostly favourable values of petrophysical properties and recoveries [4]. The reservoir permeability is significantly decreased in the smaller reservoirs: The largest fields could have the longest production.

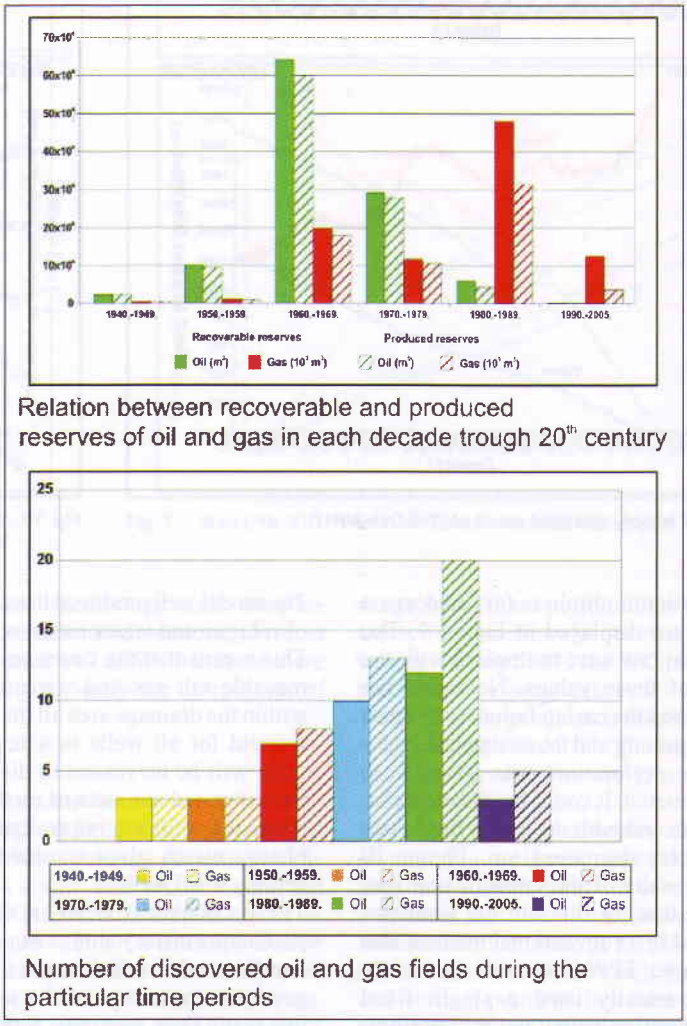

Fig. 1 Comparison of reserves (1a) and discoveries (1b) through decades in 20th century

The results obtained can be viewed in context with the results published earlier in this journal [2]. Dobrova et al. ranked Croatia in third place according to the remaining recoverable liquid reserves in the central and eastern European states at the end of 2002 (Romania first, 39%; Ukraine second, 25%; and Croatia, Austria and Belarus third, 6%). This is why we have rechecked our calculated values of recoverable reserves, cumulative production and remaining reserves against values published earlier [2].

It is obvious that more recent production data from Croatian hydrocarbon regions are lower, compared with data published in 2003. Even if condensate reserves are added

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Table 1 **Comparison of Croatian's recoverable reserves of oil and gas, cumulative production and remaining reserves based on data from two sources**

DOBROVA et al., 2003 [2]						*Presented analysis*					
Recoverable reserves		Cumulative Production		Remaining Reserves		Recoverable reserves		Cumulative Production		Remaining Reserves	
Oil (10^6 m^3)	Gas (10^9 m^3)	Oil (10^6 m^3)	Gas (10^9 m^3)	Oil (10^6 m^3)	Gas (10^9 m^3)	Oil (10^6 m^3)	Gas (10^9 m^3)	Oil (10^6 m^3)	Gas (10^9 m^3)	Oil (10^6 m^3)	Gas (10^9 m^3)
141.18	108.11	109.70	26.16	31.48	81.95	112.06 (10.73)	100.67	104.05 (6.93)	64.91	8.01 (3.80)	35.76
(*reserves given in brackets at the right columns are condensate volumes)											

to oil reserves, the new values are still lower (122.79 vs. 141.18 x 10^6 m^3). Consequently remaining oil reserves in proven traps are lower, amounting to 62.5% and gas to 56.6% (Table 1).

Conclusions

Some remaining hydrocarbons could be recovered from proven reserves in the Croatian part of the Pannonian basin. It is obvious also that there are some subtle, potentially large reservoirs [3] and the remaining reserves given in Table 1 also supports this. Significant reservoir volumes can be expected in Neogene basement rocks as well as Lower and Middle Miocene sediments, consisting of different lithofacies. The targets are also typical heritage structures above pre-Neogene buried hills. In Pannonian and Pontian sediments in which the main focus should be stratigraphic traps, typically along subtle or gentle anticlinal structures, and in areas of large thicknesses of Neogene areas of differential compaction are very interesting.

References

[1] BELOŠIĆ, Ž.: Istraživanje i proizvodnja nafte i plina [Exploration and production of oil and gas]. 2nd International scientific-professional congress on petroleum industry held in Zadar, 30 Sep–3 Oct 2003, Proceedings, INA-Naftaplin, Zagreb, Croatia, 2003, S. 27–38.

[2] DOBROVA, H.; KOLLY, E.; SCHMITZ, U.: E&P Ventures in the Eastern-Central Europe Transformation States after 1989 – a Review of Expectations and Results. OIL GAS European Magazine, v. 4, 2003, S. 172–182.

[3] MALVIĆ, T.; RUSAN, I.: Investment Risk Assessment of Potential Hydrocarbon Discoveries in a Mature Basin. OIL GAS European Magazine, v. 2, 2009, S. 67–72.

[4] VELIĆ, J.; WEISSER, M.; SAFTIĆ, B.; VRBANAC, B.; IVKOVIĆ, Ž.: Petroleum-geological characteristics and exploration level of the three Neogene depositional megacycles in the Croatian part of the Pannonian basin (in Croatian). Nafta, v. 53, no. 6–7, 2002, S. 239–249.

[5] VELIĆ, J.; MALVIĆ, T.; CVETKOVIĆ, M.; WEISSER, M.; CURI, V.: Observation useful for increase of hydrocarbon fields exploitation period within Croatian part of the Pannonian basin. SGEM conference "Modern Management of Mine Producing Geology and Environmental Protection" held in Albena 16-20 Jun 2008, International Scientific Committee, Bulgaria, 2008, S. 567–574.

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