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Early Monetisation of a Medium Size Onshore Field – A Case Study

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Abstract

Major oil & gas fields world over, be onshore or offshore, have always been given due importance for their early and or fast track development. However, most of the time, the concepts and strategies adopted for them are not suitable for small and medium size fields[1]. With most of the new discoveries now falling in small and medium size categories, E&P companies are thinking of ways and means for their early and efficient exploitation. Continual advancement/improvement in exploration / exploitation of hydrocarbons has further strengthened this approach[2] . These efforts on one hand help in realising early cash flow while on the other hand allow simultaneous refining of reservoir models. There are additional benefits coming in terms of better understanding of reservoir performance before building full fledged development plans and firming up mind for installation of expensive and long term facilities.

No doubt, all this is possible if proper integration of both soft (seismic) and recurring hard (logs, core, well testing, production performance) data is executed timely [3,4] . This integration of data also provides an opportunity to understand reservoir drive mechanism which helps in identification of proper pressure maintenance techniques and even giving an insight on designing suitable EOR techniques all at an early stage of exploitation. The present paper deals with a successful case study of early monetization of a medium size onshore field of ONGC, discovered in 2003 and located in NE sector. The multilayered oil reservoirs (Units- I, II, III & V) belonging to late Eocene to Oligocene age have been under fast track exploitation with water injection in one of the units. The top most gas bearing Unit-VI is presently not being exploited keeping in mind future requirements w.r.t artificial gas lift and or gas injection. Detailed core, fluid (PVT) and other reservoir properties have also helped in envisaging the feasibility of miscible gas injection alongwith water injection as EOR process for Unit-V. If considered for implementation in near future, this may significantly lead to additional recoveries over simple water injection and ultimately make value addition in optimal exploitation. Presently, the field (Units- I, II, III & V) is contributing oil @ 310 m3/d through 10 producers with water injection @ 200m3/d through 2 wells. The main Unit-V has already contributed about 10 % of its in-place volume. The full fledged development scheme under implementation envisages a plateau oil rate of 855 m3/d through 21producers with peak water injection of 725 m3/d through 6 wells leading to an overall recovery of around 28%.

The fast track development of this field has clearly established that case specific and timely integration of both soft and recurring hard data has helped in early and better understanding of the reservoir behaviour which is so essential for good reservoir management. At the same time, it has also brought in additionally attached economic benefits.

Introduction

Timely development of small and medium size fields has always remained an issue as compared to development of major oil & gas fields because of huge economic benefits attached with the later category of fields. However, keeping in mind, the fast changing scenario in the industry w.r.t. the ever increasing demand of oil and most of the present day discoveries falling in small and medium size categories, world-wide E&P companies are diverting their attention towards early and efficient exploitation of these fields. Continual advancement/improvement in exploration/ exploitation of hydrocarbons has further strengthened this

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approach. Fast track development of these fields helps in early cash flow and along with brings the opportunity of refinement of reservoir models at an early stage.

This paper deals with the case study of early monetization of a medium size onshore field of ONGC, located in NE sector. This field, discovered in 2003, is situated NW of one of the main oil producing fields. The discovery well, A-1 drilled based on 2D seismic data encountered four thick sandstone hydrocarbon bearing units (Units-I, II, V & VI from bottom to top) out of which three units were tested to be oil bearing and one as gas bearing. Keeping in mind good potential of different units and the nearby available production evacuation facilities, the discovery well was immediately put on sustained production from Unit-V. Planning early monetisation of the field, one development location, A-2 was immediately drilled close to A-1 for early exploitation of Unit-I. Revised maps (generated by incorporating 3-D seismic and VSP (recorded in A-1) data, led to drilling of another exploratory location, A-5 in the adjacent block. Encouraged by results of A-1 & 2, a fast track development plan was conceptualized and implemented for Units I & V. Simultaneously, based on good results of A-5, one more development location, A-9 was drilled for early monetisation of these units. Drilling results of development location, A-6 also established another Unit III as oil bearing. Meanwhile, maps for all the levels were again revised considering 3-D PSDM data[5] along with newly drilled wells data. For uniform exploitation of four oil bearing units (Units- I, II, III & V), second phase of development considering 14 new wells and envisaging water injection for unit-V is under implementation. When fully implemented, this scheme envisages a peak oil rate of 855m3/d through 21 producers and with peak water injection of 725m3/d through 6water injectors. This will lead to an overall recovery of around 28%.

Approach Adopted for Present Case Study

This case study deals with the approach adopted for fast track development of a medium size onshore field of ONGC. The field was discovered in 2003 and is located in NE sector very close to a major oil producing field. The discovery well, A-1 was released on 2-D seismic data study which brought out a hanging wall fault closure against a NE-SW trending reverse fault at Unit-II level with an amplitude of 20 msec and areal extent of 3.5 SKM. The well encountered four thick sandstone hydrocarbon bearing units (Units-I, II, V & VI from bottom to top) belonging to late Eocene to Oligocene age at depths varying from 3300 to 3750m. During production testing, Units-I, II & V produced commercial quantities of oil whereas Unit-VI produced gas. The initial testing results of different units are given in (Table-1).

Table-1

Object/ Interval (m)	Bean (mm)	Q0/Qg (m3/d)	GOR (v/v)	THP (KSC)	Oil Gr. (API)
Unit-I (3660-3683)	6	110	210	130	32.8
Unit-II (3602-3628)	6	80	530	170	43.6
Unit-V (3473-3492)	6	84	370	145	35.8
Unit-VI (3434-3450)	6	67000	----	215	---

For early and better understanding of reservoir characteristics, detailed bean studies along with pressure build-up studies of all the units were carried out. Variation in API of produced oil showed different nature of these reservoir units. This was also confirmed through existence of different OWC's as observed on logs for different units. Further, to have a better feel of reservoir fluids behaviour, reservoir bottom-hole samples were also collected for all the oil bearing units. The initial reservoir pressures for all the units were found to be varying between 350 and 360 KSC which showed the reservoirs to be hydrostatic in nature. The discovery well, A-1 was immediately put on sustained production from unit V and one development well, A-2 was drilled close to A-1 for early exploitation of Unit-I. Conventional coring was planned in this well for detailed laboratory studies. Revised maps generated by incorporating 3-D seismic and VSP (recorded in A-1) data, led to drilling of another exploratory well, A-5 in the adjacent block (Fig.1).

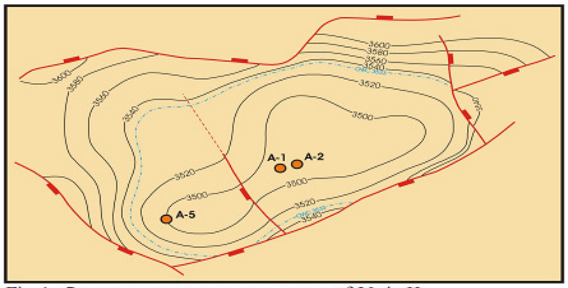

Fig.1: Structure contour map at top of Unit-II

Encouraged by the excellent results of wells, A-1 & A-2 and availability of nearby evacuation facilities, fast track development approach was conceptualized and implemented for Units I & V. Simultaneously, based on good results of A-5, one more development well, A-9 was drilled for early monetisation of these units. The drilling results of development well, A-6 additionally established existence of another new oil pool as Unit-III. This showed the variation in spatial distribution of these different units. A log correlation showing different units in some of the wells is shown in Fig. 2. The detailed log analysis

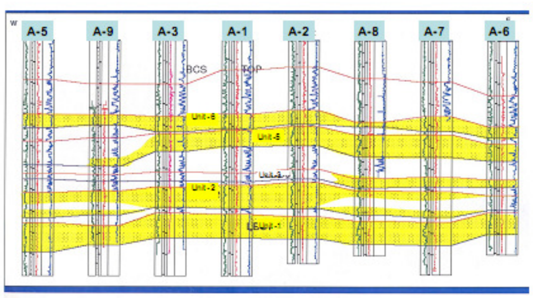

Fig.2: Log correlation of various units in different wells

shows Units I, II & VI to be quite extensive over the field whereas Unit V is extensive in eastern part and relatively shaly in other areas. Unit-III is a restricted body and is developed in eastern part only. Oil water contacts were seen in all the oil bearing units whereas oil shale contact was observed in gas bearing Unit-VI. All the newly drilled wells were thoroughly tested to have still a better idea about the reservoir characteristics. In general, crude oil is found to be mainly paraffin based (wax content 10 to 15 %) with high pour point (25 to 30^0 C). Apart from routine basic studies, special core studies were done to generate relative permeability curves, determining quality of water to be injected and designing of suitable future EOR process. Pressure build up studies like core studies have shown the different units to be associated with low permeability. Integrating all the relevant information obtained from newly drilled wells with 3-D PSDM data, the maps were once again updated for all the levels (Fig.3).

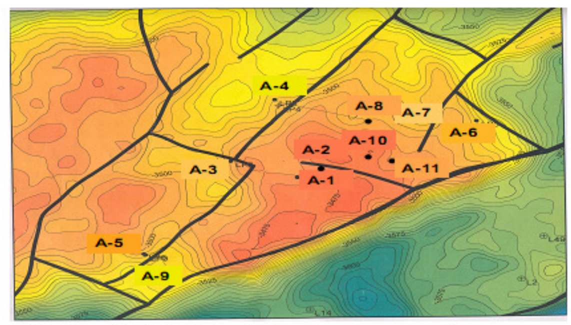

Fig.3: Revised structure contour map at top of Unit-II

The new model has brought out three sets of fault system,ENE-WSW trending fault, NNE-SSW trending faultsystem with dominant strike slip component and theWNW-ESE trending cross faults. They compartmentalizethe discovered field, western block and area further north insmaller blocks. The drilling of exploratory locationavailable in the western block will confirm the extension ofthese units there as well as the hydrodynamic continuitywith the present main block. This may help in moreaccretions and still better understanding of the producingreservoirs. However, within main block, in conjunctionwith presence of other minor faults, both initial pressuresand build up data have helped in better understanding offluid flow. At this stage, unit-V has already contributedaround 10% of its initial volume whereas other units havealso started building up their contribution. The fieldperformance is shown in Fig.4. Based on this new model, reservoir characteristics and the production performance,simulation studies have been carried out for uniformexploitation of these units. Water injection has been

Table-2

Parameter/ Unit	I	II	III	V
Bubble Point Pressure, KSC	350	349	356	340
Oil Density, gm/cc	0.84	0.82	0.78	0.83
GOR, V/V	342	410	677	370
FVF at Pb V/V	1.83	2.01	2.78	1.92
Permeability (Av.), md	10-200	1-30	20-30	1-30
OWC, MSL	3582	3548	3483	3404

considered for Unit-V to arrest the declining reservoir pressure. Further, gas bearing Unit-VI has not been considered for exploitation at this stage keeping in mind future gas requirements w.r.t. artificial gas lift and or gas injection. The average values of various parameters as considered in the model are given in Table-2.

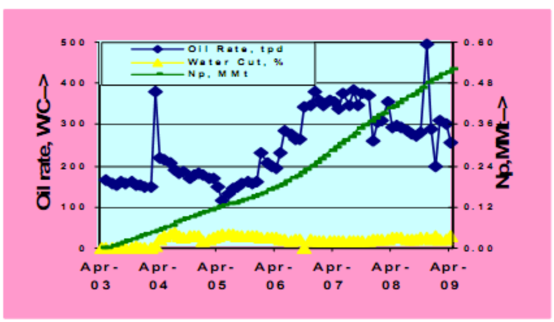

Fig.4: Field production performance plot

This Phase-II development, which considers 14 new development wells for different units, apart from some work over jobs and conversions, is already under implementation. When fully implemented, the scheme envisages a peak oil rate of 855 m3/d through 21producers and with peak water injection of 725 m3/d through 6 water injectors. This will lead to an overall recovery of around 28 %. Additionally, preliminary laboratory studies have shown miscible gas injection as a good EOR process for these units. If considered suitable for implementation at field level at a later stage, this might lead to substantial improvement in recovery factors.

Conclusions

- The present case study pertaining to early monetisation of a medium size onshore field has clearly established that case specific and timely integration of both soft and recurring hard data has helped in early and better understanding of the reservoir behaviour.
- This integration of data has helped in countering uncertainties at initial stage of development, providing an opportunity to identify proper pressure maintenance techniques and even giving an insight on designing suitable future EOR techniques.
- Early monetization of the field has also helped in realising early cash flow even before building full fledged development plan and installation of long term facilities.

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