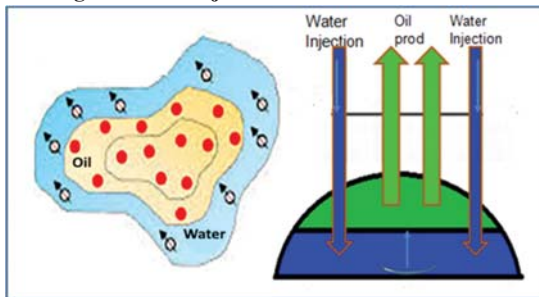


Chapter 1

Introduction

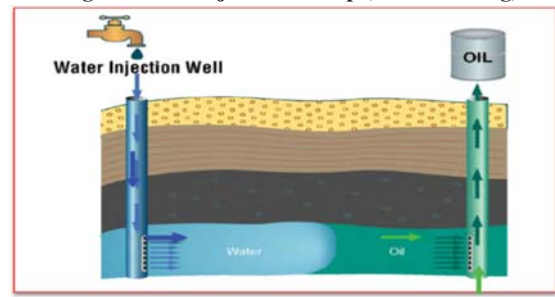
Oil and Natural Gas Corporation Limited (ONGC/ Company) is a Maharatna Public Sector Undertaking (PSU) contributing around 70 *per cent* of domestic production of crude oil in the country, of which around 59 *per cent* is produced from the western offshore nomination fields. Oil production is divided into three distinctive phases, *viz.*, primary, secondary and tertiary. During the primary stage, the natural reservoir energy drives the production. The secondary stage is aided by injection of external fluid, commonly water or gas, into the reservoir to increase the pressure and thereby stimulate oil recovery. Water flooding remains the most prominent oil recovery method. In tertiary stage, Enhanced Oil Recovery¹ (EOR) method is required to produce residual oil trapped in reservoir. Primary and secondary methods combined produce up to 50 *per cent* of the oil in place and for the remaining oil trapped in the reservoir (residual oil), Enhanced Oil Recovery (EOR) method arises in the tertiary phase.

Fig 1.1 Water Injection: Pressure maintenance



The water is injected in the aquifer through several injection wells surrounding the production well.

Fig 1.2 Water injection: Sweep (water flooding)



The water is injected in the oil zone to create sweep effect.

Water is injected to support pressure of the reservoir (known as voidage replacement) and also to sweep or displace oil from the reservoir and push it towards the well. Water injection is one of the most useful techniques for enhancing the oil production not only because of the low cost of water but also because of the characteristics of water which helps sweep the trapped oil efficiently. It is the most successfully used secondary oil recovery method in oil fields of all sizes all over the world.

1.1 Water injection process at offshore

The water injection process consists of drawing raw seawater from the depth of about 30 metres by seawater lift pumps. This water is filtered and treated with chemicals to remove suspended solids, biological growth and dissolved oxygen. The treated water is pumped by injection pumps to various well platforms. Water injection facilities consist of water

¹ EOR is a method of oil recovery by injection of materials not normally present in the reservoir.

injection processing platform, water injection line, water injection well/ string², metering system for measuring the amount of water injected in each well/ wells, etc.

1.2 Development of Mumbai High, Neelam and Heera fields

Mumbai High field, located in the Arabian sea at about 165 km west-north west of Mumbai city in the western offshore, is the largest and most prolific oil field in India and was put in production in May 1976. The field has been divided into two blocks - North and South and has estimated initial-oil-in-place of 1,696 million metric tonnes. Mumbai High field progressed over a period of time through series of development programs since 1976. In order to improve oil recovery from the field, a major re-development³ program was launched during 2000-01. Water injection in Mumbai High North field was initiated in April 1984 and three rounds of development took place from 2001 to 2018. Re-development scheme (Phase IV) approved in April 2019 is presently under execution. Mumbai High South field was put on production in 1980 and water injection commenced in 1987. The last three rounds of development took place from 2001 to 2018. Re-development (Phase IV) scheme approved in February 2019 is presently under execution.

Heera field was discovered in September 1977 and put on production in November 1984. Heera field produced oil under depletion drive⁴ for about six years and water injection was started in September 1990. In this field, two rounds of development have happened during 2001-05. Heera re-development schemes Phase I and II (HRP I & II) were taken up from 2006 and 2012 respectively. HRP III was approved in May 2019 and is presently under execution.

Neelam field started in 1989 and full-fledged development commenced from 1993-94. Water injection in the field was started in 1994 for pressure maintenance. In order to improve oil recovery, a major scheme, viz., 'Improved Oil Recovery (IOR)' was implemented in 2001-02 and completed by 2005-06. Neelam re-development scheme (NRP) launched in 2015, is presently in progress.

1.3 Water injection infrastructure

In western offshore, there are seven water injection platforms, five in Mumbai High field and two in Neelam-Heera fields having total capacity of 20.57 lakh bwpd (barrel of water per day) which were commissioned during the period from 1984 to 2006. The treated water is injected through 102 wellhead platforms in 315 wells/ strings (Mumbai High field) and 30 wellhead platforms in 80 injection strings (Neelam and Heera fields).

² *Injection well/ string - Injection well is a well through which water is injected into reservoir to maintain reservoir pressure. Injection well may have a single string or dual strings.*

³ *Redevelopment schemes are rolling plans. They are implemented for enhancing the oil recovery through Improved Oil Recovery (IOR) methods like using new inputs (producing wells/ injection wells), new platforms with facilities, pipelines to target bypassed oil and maintain reservoir pressure through water injection.*

⁴ *A depletion-drive reservoir is characterised by a rapidly increasing gas-oil ratio from all wells. After the reservoir pressure is reduced, gas evolves from solution throughout the reservoir. This is very inefficient as it will produce relatively little of original oil in place.*

Details of water injection infrastructure created in Mumbai High and Neelam and Heera fields are given in table 1.1.

Table 1.1: Water injection infrastructure/ expenditure

Description	Mumbai High field		Neelam & Heera fields	
	Number	Expenditure (₹ in crore)	Number	Expenditure (₹ in crore)
Platforms	5	2,607.01	2	928.49
Wells	260	1,017.51	73	647.55
Pipelines	130	3,945.16	33	930.39
Total		7,569.68		2506.43
Average annual Opex		731.30		232.64
<i>Source: Data received from Central accounts (Mumbai region), ONGC.</i>				