New Oil Generation

Exothermic Chemical Treatment



Exothermic Chemical Treatment (ECT®): Innovative approach for targeting heavy crude oil reserves

Exothermic Chemical Treatment (ECT®) introduces a new generation of modern Enhanced Oil Recovery technologies. ECT® combines modern science and technology as it stands for a thermochemical stimulation fully controlled and commanded by in-house developed state-of-the-art hardware and software platforms. Chemical components and the process used in the ECT® method allow to introduce heat directly into the reservoir without any losses and, thus, to achieve a radical drop in oil viscosity. ECT® application represents enhanced oil flow and immediate and dynamic boost in oil production.

ECT® platform uses unique chemical formulae in combination with advanced logging and controlling system interconnected with highly responsive sensors installed in our BHA to monitor and control the treatment at every moment. The technology works with chemical reactants being pumped into the well production zone using our tech units where an exothermic chemical reaction is triggered. This exothermic chemical reaction does not only transfer heat into the reservoir but also releases a significant volume of N2 gases and creates pressure in the reservoir, all the process with zero energy losses on the outcome. Using the energy contained in the chemical reactants eliminates the need for high-cost conventional energy generation from power plants or massive power generators, which are standard in case.

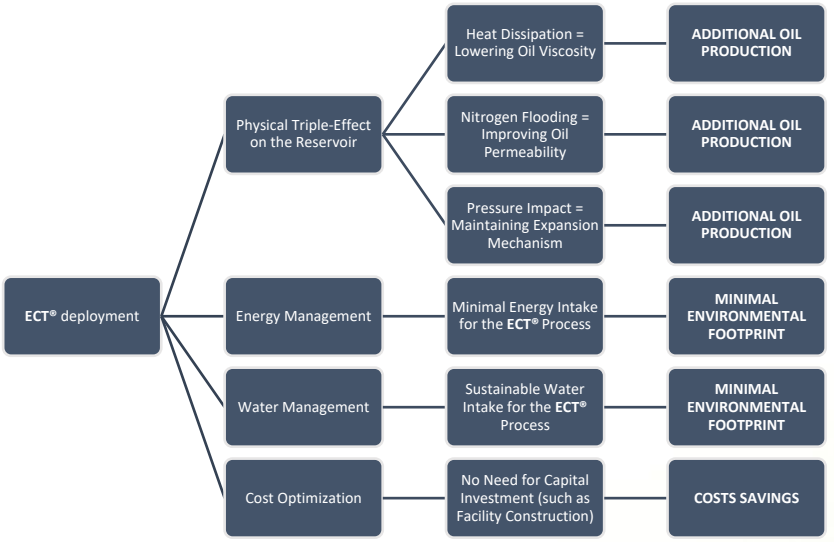
ECT® is a game-changer in the field of EOR technologies also in terms of water and energy efficiency. In today's world, conserving the quantity and quality of water resources is essential for every country's long-term growth and sustainability. In the oil industry, such a goal can be reached by deploying smart technologies low on water consumption, such as ECT®.

The ECT® method is globally patented and New Oil Generation is the only licensed and certified provider of the ECT® service worldwide. NOG provides complex services including pre-treatment consulting such as reservoir and well analysis; geothermal and structural image and core analysis; feasibility study of ECT® deployment; operation documentation; post-treatment monitoring and reservoir and well assessment for consequent deployment of EOR methods.



Fig. 1: The ECT® technology units lay-out on the wellsite

ECT® focuses on complex solutions within the upstream sector including cost-reduction and sustainable water and energy management



The overall potential benefits of ECT® include:

- Provides a new thermal recovery method to improve heavy oil production.
- Maximizes heat delivery efficiency and minimizes heat losses.
- Can be used to induce fractures for an improved drainage radius.
- Can be applied to deep heavy oil and tight oil reservoirs.
- Can be applied to both onshore and offshore fields.
- Offers a low cost, less labour-intensive delivery of thermal energy in the reservoir (no steam plant and facility are needed).
- Reaction by-products do not contain any damaging materials or residual leftovers.
- Presents minimum safety issues — it occurs downhole, so there is no surface exposure.
- Has a reduced footprint, is environmental friendly, requires no generators, and produces no toxic emissions.



FUTURE OF THE HEAVY OIL EXTRACTION BY CEO:

Vast heavy oil reserves available in various parts of the world are becoming increasingly important as a secure future energy source. According to some estimates, about 70 % of all the liquid oil of all types estimated today falls into the category of heavy oils (<20° API gravity). Thermal Enhanced Oil Recovery (EOR) remains the most frequently used method for extraction of heavy oils. Thermal EOR methods are based on introducing heat into the reservoir in order to reduce viscosity of the heavy oil. The conventional and widely used methods are the Cyclic Steam Injection or Stimulation (CSI/CSS), Steam flooding and Steam-Assisted Gravity Drainage (SAGD). All these methods require steam to be generated on the surface and injected into the petroleum reservoir. Most of the energy consumed during thermal EOR is due to steam generation. Such treatments are associated with enormous capital investment in the construction of steam-generating facilities, special well completion and surface steam pipelines with special insulation.

In the continuous and increasing demand for oil from unconventional heavy-oil reservoirs and a call for smarter and economical methods to cope with the recent fluctuations of oil prices, ECT® represents an optimal solution. ECT® assumes the role of a leading environment-friendly technology allowing the oil industry to stimulate heavy-oil reservoirs and increase the current production by up to 1 000 %. ECT® thermo-chemical stimulation of hydrocarbons achieves a significant drop in oil viscosity, thus making the oil easier to extract. The technology uses unique chemical formulae, so called Binary Mixtures, in combination with the state-of-the-art logging and commanding system interconnected with highly responsive sensors installed in an in-housed manufactured BHA to monitor and control the treatment at every moment. Our approach is more complex as we aim at energy efficiency, operation economics and environmental footprint of the technology. ECT® operations do not require any special surface facilities and energy to generate steam. Unlike the steam-based methods, the heat losses using Binary Mixtures are negligible due to direct and targeted heat transfer and dissipation into the reservoir.

New Oil Generation company (NOG), as a developer and service-provider of the innovative ECT® method, has dedicated huge efforts to advance this concept and transform the technology into the state-of-the-art tool for every heavy-oil reservoir operator willing to take the step towards the future. Prior to bringing ECT® to the market as unique, fully functional, and safe service for oil industry, the technology has gone through mathematical modelling and has been lab-tested and field-tested during a 15 years-long research and development stage.

Jakub Hodinář
New Oil Generation CEO

ECT® Application Principles

ECT® technology uses a combination of chemical reactants called Binary Mixtures injected as aqueous solutions into the well to heat and pressurize the reservoir pay zone. Aqueous solution of chemical reactants is pumped through two separate channels to the well and it goes down under the packer into a specially manufactured tubular chamber called New Oil Generation Injection Spearhead where chemicals react and begin generating a significant amount of energy which heats the pay zone efficiently and generates nitrogen gas. ECT® leaves a long-lasting positive effect on the oil properties, especially viscosity.

ECT® increases the oil mobility by:

- decreasing the oil viscosity
- increasing relative oil permeability
- decreasing relative water permeability

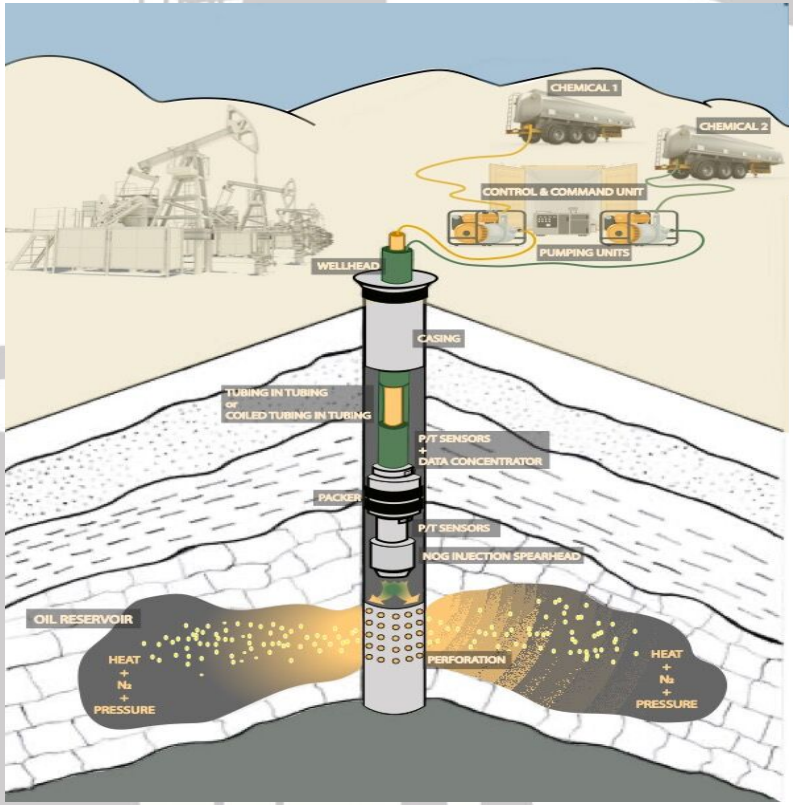


Fig. 2: ECT® technology set-up schematics

The system is fully controlled by NOG control and command unit. This in-house developed software platform commands the integrated logging system interconnected with highly responsive sensors. Technological guidelines ensure proper and secure procedures and the ECT® application leaves no permanent changes in the well integrity. Electronic control and command system built on SIEMENS platform can work in automatic, semi-automatic and manual modes. SW and HW tools for the process management collect and evaluate real-time data from the downhole pressure and temperature sensors and are able to respond to any oscillations in the process.

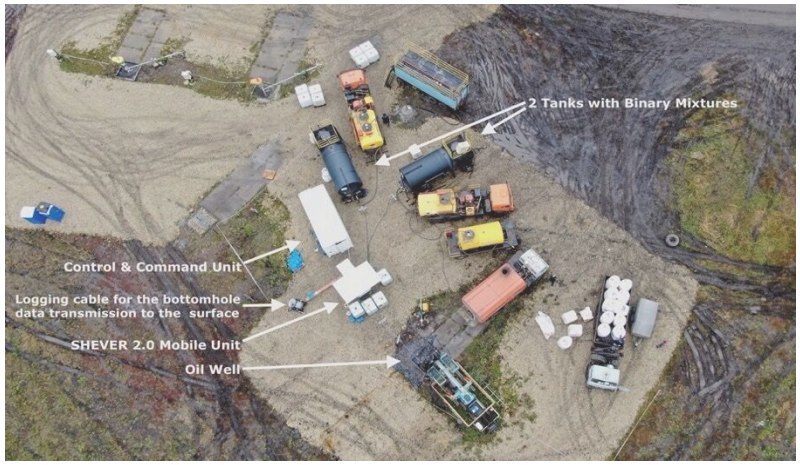


Fig. 3: The ECT® technology units lay-out on the wellsite

General Criteria for ECT® Application

As the viscosity of heavy oil is very responsive to temperature changes, conventional thermal steam-based oil recovery technologies are widely used. ECT® is radically challenging these traditional steam-based methods not only in terms of efficiency, but also due to low investment costs (no additional infrastructure required), fast deployment and minimal environmental impact (regarding carbon footprint, energy and water use).

Formation type	Carbonates, Terrigenous (not clayey)
Preferred type of reservoir	Carbonates with fracture porosity
Porosity	12 – 20 % (natural fracturing)
Permeability	> 35 mD
Net-pay thickness	> 5 m
Water cut	< 20 %
Oil viscosity	10 - 28°API

ECT® Configurations: operation programmes

The ECT® operation is run by NOG in three configurations:

1. **ECT® Huff&Puff Well Stimulation Programme** – similar to the Cyclic Steam Stimulation (Fig. 4);

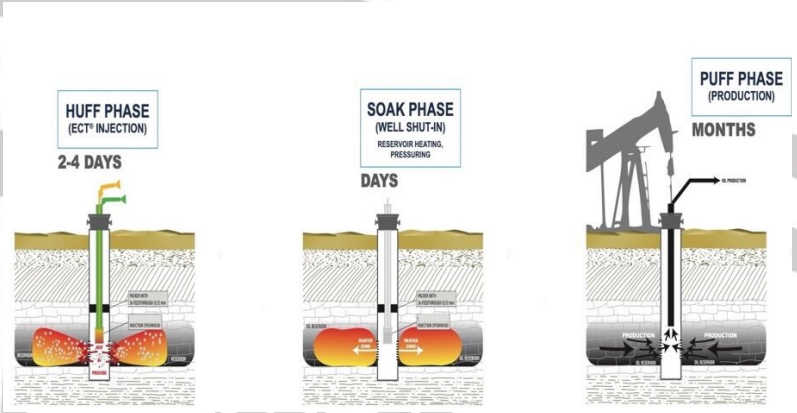


Fig. 4: The ECT® technology configuration: Huff&Puff

2. **ECT® Injection/Production Programme** – NOG BHA remains in the well for either continuous or periodic injection;

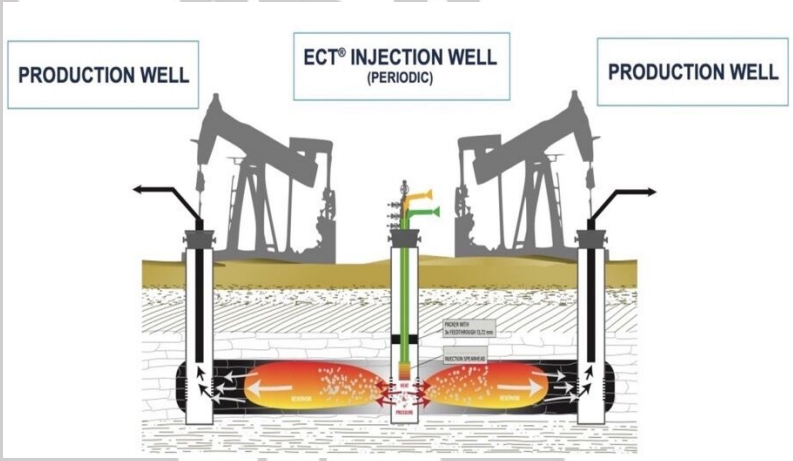


Fig. 5: The ECT® technology configuration: Injection / Production

3. ECT® SmartField Programme – upgraded Huff&Puff periodic well stimulation with a special NOG BHA installed under the Y-tool with Electric Submersible Pump (ESP) and continuous pre- and post-treatment monitoring (Fig. 5). ECT® BHA is installed below an ESP on a Y-tool (under a packer) for a period of time (usually 12 – 24 months) which allows to conduct ECT® operations periodically with no need for costly workover operations and at the same time ensures continuous monitoring, both pre- and post-treatment.

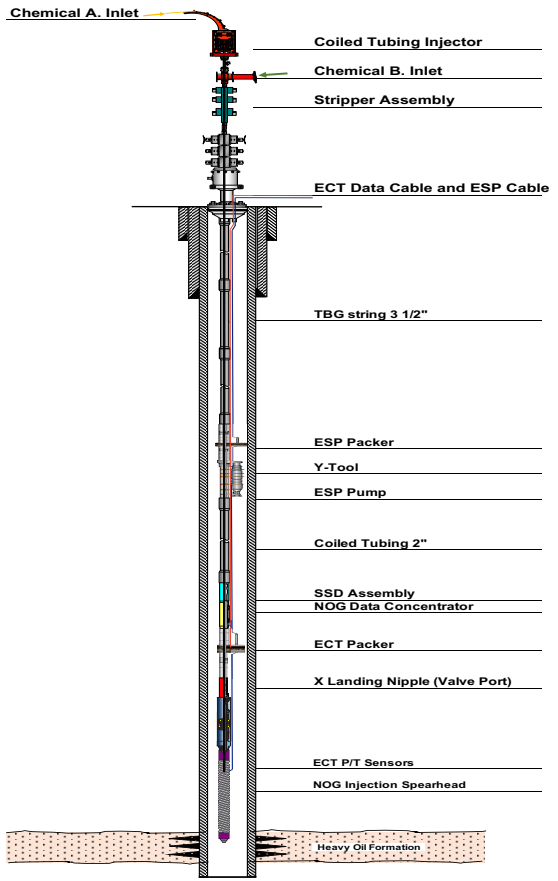


Fig. 6: ECT® SmartField Programme

Additional Oil Production Effects

ECT® Binary Mixtures (BM), specially designed aqueous solutions of chemical reactants used in various concentrations, are injected into the reaction zone of the well in determined injection rate and molar ratios and are subject to the assessment of the conditions and parametres of each well. Additional Oil Production (AOP) in bbls per 1 tonne of used Binary Mixtures with regards to the oil viscosity is demonstrated in Fig. 7. Data from real-life stimulations along with numerical calculations were used as the input data in the graph. Test-verified AOP ranges from 60 to 100 bbls per 1 tonne of BM chemicals per 1.0 m of net production reservoir thickness. For the medium-viscosity oil (10 - 50 cP), the ECT® stimulation showed the additional production of oil at 30 - 40 bbls per 1 tonne of BM chemicals per 1.0 m of net reservoir thickness. The efficiency of the ECT® process increases along with increasing oil viscosity. For the oil with viscosity of 500 cP, the AOP can reach 105 bbls per 1 tonne of BM chemicals per 1.0 m of net production reservoir thickness.

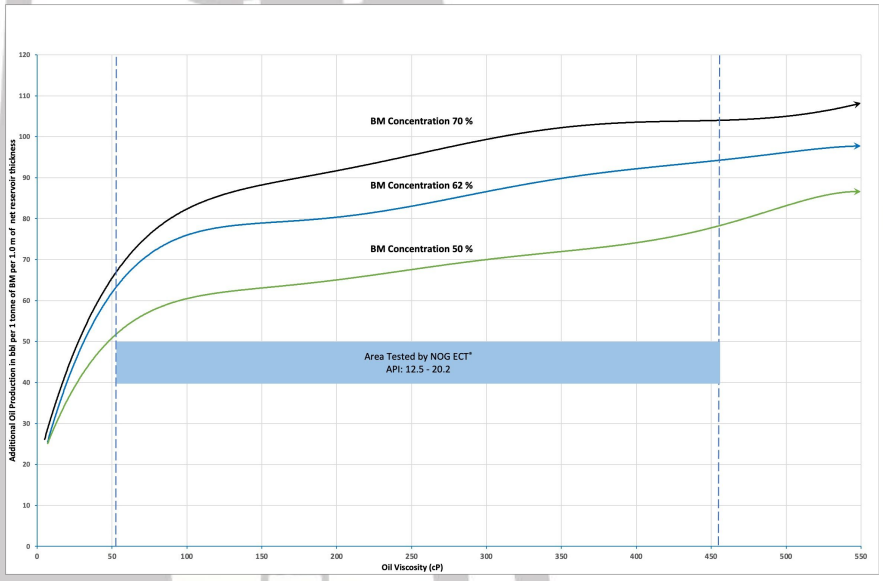


Fig. 7: Additional Oil Production (AOP) in bbls per one tonne of used BM chemicals per 1.0 m of net production reservoir thickness

Reducing Oil Viscosity

The key factor affecting viscosity is temperature. The relation between the temperature and viscosity is given in Fig. 8. For the graph purposes, oil samples with different viscosities/gravities from one oil field were used. The viscosities/gravities may vary considerably, but as the ECT® test demonstrated, the heavy crude oil changed its gravity from the original 16° API to 32° API after being heated to 100° C.

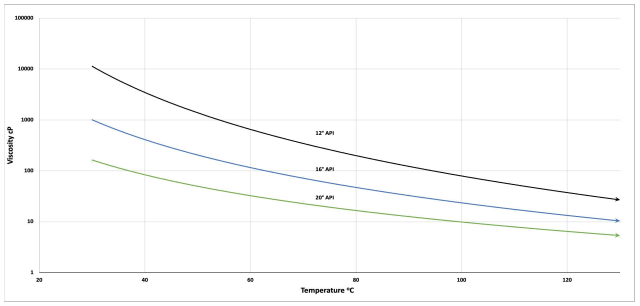


Fig. 8: Oil Viscosity (cP) in relation to the Temperature change (°C)

Oil Production Boost

Increase in oil production proportional to the amount of injected Binary Mixtures. Before each ECT® operation, technical and economic assessments are conducted giving the basis to a proposal of optimal design, volume and concentration of Binary Mixtures designed for a particular reservoir and well. The proposal is drafted with the objective to make the well stimulation as efficient as possible with regards to the highest additional oil production. Fig. 9 shows up to 10-fold increase in the oil production using Binary Mixture solution in volumes ranging from 50 to 80 tonnes.

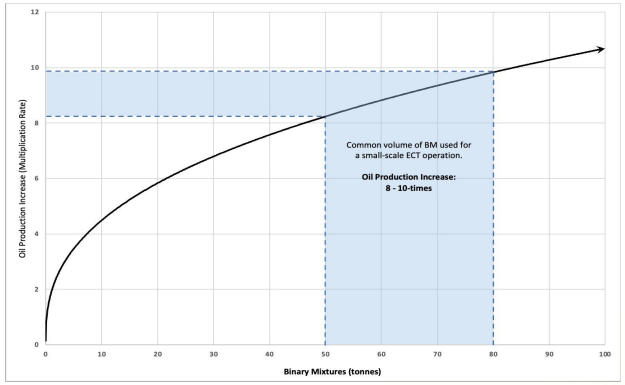


Fig. 9: Oil Production Increase (Multiplication Rate)

ECT® Heat Transmission

The effectiveness of the ECT® process depends on two factors.

1. Reservoir and oil properties such as reservoir thickness, porosity, permeability, oil saturation, viscosity, rock thermal conductivity and diffusivity.
2. Operational conditions such as BM chemicals molar ratio and injection rate, maximum allowable downhole pressure, and temperature. Figure 10 shows how the generated heat is dissipated in the reservoir under ideal homogeneous conditions. This case assumed net-pay thickness 1.00 m and 100 tonnes of used Binary Mixtures. Heat generated by the ECT® treatment affected the well radius of up to 42.9 meters.

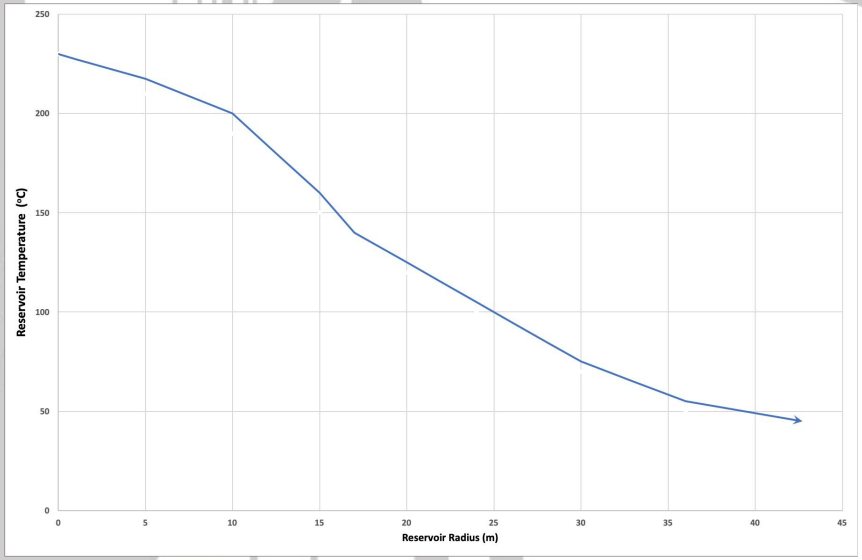
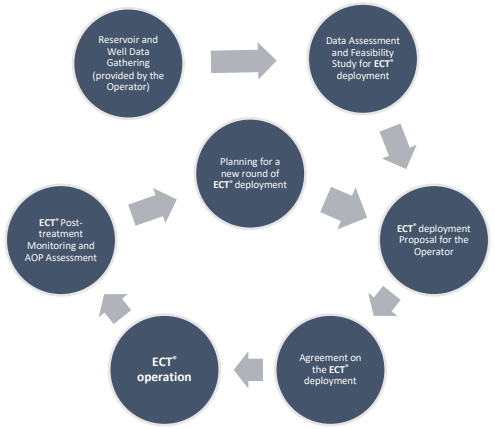


Fig. 10: Temperature gradient in the reservoir during ECT®

Standard Process for ECT® Huff&Puff Programme



Standard Process for ECT® SmartField Programme (no workover)



Operational Requirements

- Workover rig for standard operation, POOH and RIH tubing string
- Coiled Tubing Unit (possibly)
- Workover crew 24/7
- Equipment for well preparation and completion
- Pump truck for the well test
- Technical fluid and tanks
- Tubing for well completion
- Wellhead completion in cooperation with NOG
- Electric supply 35 kW/400V

ECT®: Minimising the Impact of the Oil Industry on the Environment

Environmental footprint is one of the main strategic challenges the oil & gas sector is facing in the long-term. Huge R&D investments are allocated world-wide to find technical solutions to reducing CO2 emissions in the whole value chain. Oil producers are getting under political pressure of both governments and non-governmental organisations to come up with cleaner technologies reflecting higher environment-protection requirements.

Enviroment protection is a complex issue and water resources, and their management plays a crucial part in it. Water in terms of both quality and quantity is becoming a global problem not only in traditionally dry regions of the world. More than 80 % of proven oil reserves is located in the Middle East. At the same time, diminishing water resources are causing a plenty of problems ranging from the water unavailable for agriculture production to a lack of safe drinking water for wider population. Based on the latest scientific predictions, the situation will further deteriorate in a long-term perspective. Under these circumstances, it is not sustainable to continue using great portions of water resources for oil production stimulation as there will be no water available in the place. Water scarcity is not an issue only in the Middle East. Authorities in many countries are setting very strict norms to oblige oil operators to use the water-protection friendly methods because they understand risks of misusing or polluting their water resources.

Simplified comparison of ECT® and Cyclic Steam Stimulation in terms of energy efficiency, greenhouse gas emissions and water consumption.

	CSS	**ECT®**	Unit
Energy-Water Ratio (Energy/Heat transmitted to the reservoir via 1 m^3 of used water)	0.35 - 1.6	**up to 4**	GJ / m^3
Energy input needed to transmit 1 GJ of Heat to the reservoir	0,4	**close to zero**	MWh
CO_2 Emission	0.60	**0**	kg / day
SO_2 Emission	0.01	**0**	kg / day
NO_x Emission	0.08	**0**	kg / day

New Oil Generation and its researchers worked hard to develop the ECT® technology, which meets the highest environment protection requirements and does not misuse water resources as it uses up to 11-times less water than conventional EOR technologies. Also, the Binary Mixtures are designed to avoid any harm to the environment with potentially dangerous chemicals or residues. In combination with its efficiency in terms of need for almost zero energy input, ECT® represents a brand new generation of Enhanced Oil Recovery methods defined as environment-friendly green technologies for 21st Century.

ECT® is an innovative Enhanced Oil Recovery method for heavy crude extraction. It is capable to deal with heavy oil production issues with higher effectivity, lower costs and with no additional infrastructure demands and minimal environmental footprint. ECT® is altogether a promising alternative to conventional steam-based EOR methods, producing and combining more simultaneous effects: heating the reservoir (lowering oil viscosity), maintaining reservoir pressure and nitrogen flooding (improving permeability).

For further information or consultations, please contact New Oil Generation team via email: **info@newoilgeneration.com.**

New Oil Generation is a Research & Development company and oilfield service provider. We pride ourselves on being the pioneers in the field of innovative Enhanced Oil Recovery technologies based on the thermochemical stimulation processes. From the early stages of mathematical modelling, laboratory and field testing, New Oil Generation managed to take the technology principles and transform them throughout a 10-year consistent and thorough process into a commercially deployable state-of-the-art product. New Oil Generation is nowadays a proud patent holder of the Exothermic Chemical Treatment (ECT®) technology. Our services are complex; therefore, we also assist in the pre-treatment interpretation of reservoir and well data (geological, petrophysical, geomechanical, geophysical) and prepare reservoir or well model of thermal processes in the reservoir. After each ECT® operation, New Oil Generation multidisciplinary team runs regular analysis of the data using analytic modelling. This enables to assess the future development and to prepare recommendations for both strategic and operational actions, to manage the heavy oil production at the optimal rate and to reach the highest level of effectivity. New Oil Generation's ultimate goal is to achieve the highest possible recovery factor and increase the overall oil production while reducing both operational costs and water and energy demands.



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