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Chemical EOR solutions to increase Egypt’s oil output

BASF – We create chemistry

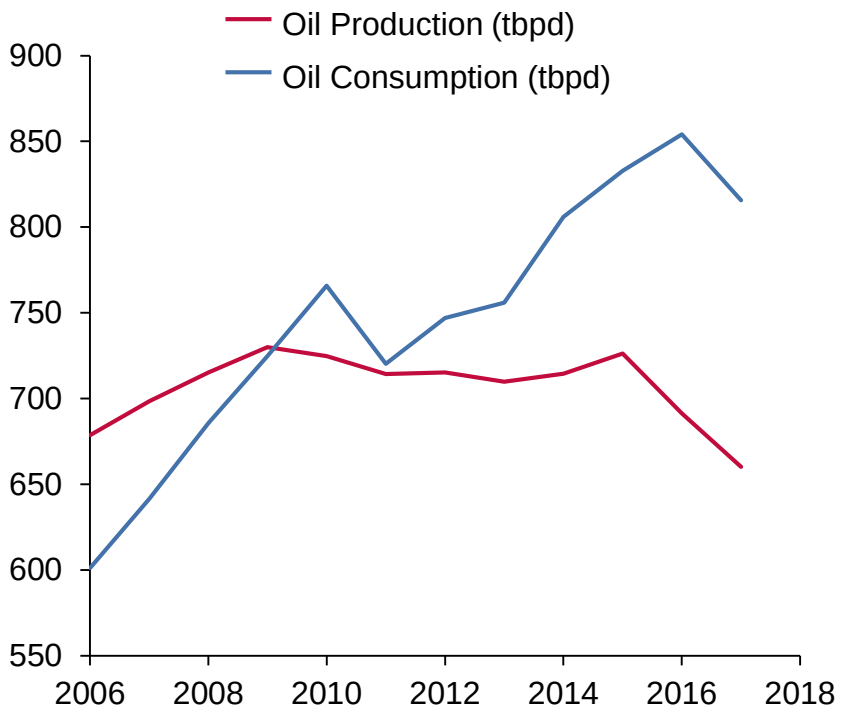
- Our chemistry is used in almost all industries
- We combine economic success, social responsibility and environmental protection
- Sales 2017: €64,457 million
- EBIT 2017: €8,522 million
- Employees (as of December 31, 2017): 115,490
- 6 Verbund sites and 347 other production sites

Innovation – meeting challenges, developing new business areas

Research for the future: With our innovative products and processes, we provide sustainable solutions for global needs.

- Expenditures for research and development
  €1,888 million
- Around 10,000 employees worldwide
  involved in research and development
- Around 3,000 research projects
- Around 800 new patents filed

Egypt is a net oil importer. Extensive primary and secondary recovery have been implemented over the years

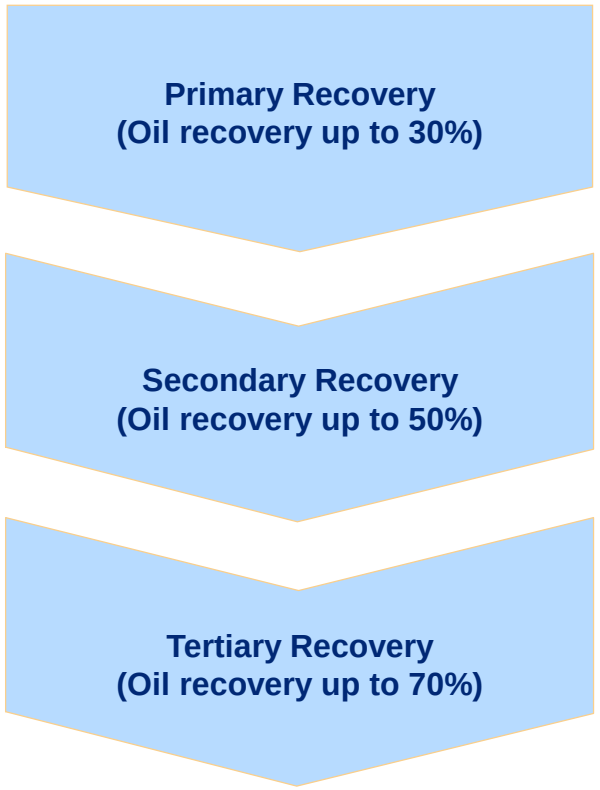


- Egypt's oil consumption has increased over the last ten years while production has not kept up with pace of consumption, making Egypt a net oil importer
- This has been accompanied by a decline in oil reserves as existing mature fields are further depleted
- Oil refining capacity in 2017 exceeds domestic oil production
- While gas production has been increasing, consumption has also increased
- Highly depleted fields have undergone extensive primary and secondary recovery over the years
- Tertiary recovery presents opportunities to increase the recovery rate further but fiscal terms are key

Opportunities to stabilize, or even increase, Egypt's oil production via tertiary recovery

Source: BP Statistical Review of World Energy (2018), Wood MacKenzie

BASF is a reliable partner with strong capabilties to unlock the full potential of chemical EOR



- Natural Flow
- Artificial Lift

- Water flooding
- Pressure Maintenance

- Chemical
- Thermal
- Gas Injection
- Other (e.g. microbial)

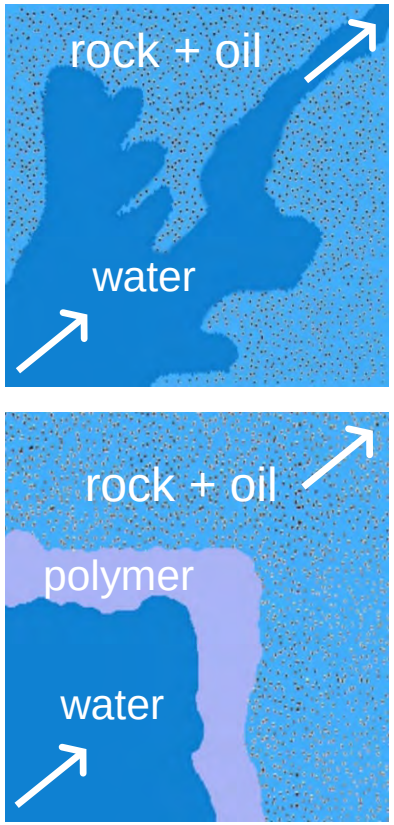
Critical factors to consider:

1. **Chemistry**: Polymers and surfactants
2. **Innovation**: cost effective solutions for untapped chemical EOR conditions
3. **Reliable supply**: produce and supply large volume at consistent quality
4. **Lab capabilities**: phase behavior, rheology, interfacial tension, core flood testing
5. **Field Service**: On-site support for EOR operations
6. **Field Equipment**: Polymer dissolution units

BASF's chemical EOR offering includes all factors listed above

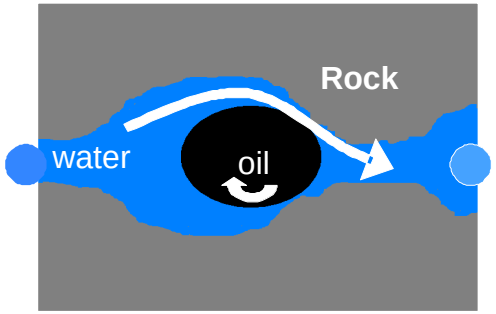
Chemical EOR Technologies: Polymer and Surfactant Flooding

- Due to viscosity difference between water and oil, no uniform displacement is achieved and a significant amount of oil is left behind (specially in case of heavy oils)
- Addition of polymers to water, increases viscosity helping to prevent “fingering” and improving sweep efficiency

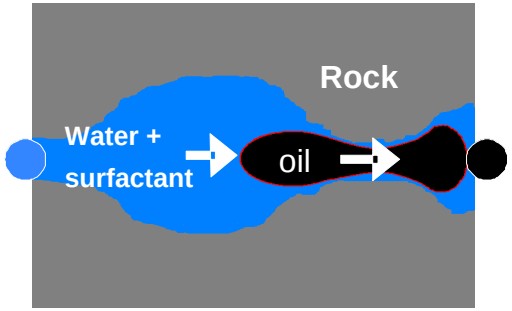


- After water and polymer flooding, oil may be trapped in the rock due to capillary forces
- Surfactant addition reduces the interfacial tension between oil and water, and hence allows the oil droplets to flow through pore throats wards the producers
- Surfactant performance depends on crude oil characteristics and reservoir conditions and must stand variations (e.g. water salinity)
- Tailored solutions are needed for each reservoir

Without surfactant



With surfactant



BASF is strong partner in polymer and surfactants for EOR

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Conclusion

- Conventional energy resources will become depleted by time
- New advanced technologies and strategies are needed to extract energy resources

This will be achieved by EOR implementation

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