APPLICATION OF DIFFERENT PSEUDOMONAS AERUGINOSA STRAINS IN MEOR EXPERIMENTS

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ABSTRACT

During the MEOR laboratory measurements we applied two different types of *Pseudomonas aeruginosa*. The strains were able to synthesize of biosurfactant and biopolymer in varying degrees. The reserves conditions can be modelled properly in the MEOR device (T=37 °C, P=1 bar). The bacterial biopolymer solutions resulted in significantly more oil turnout, than the turnout of the conventional process using water. The MEOR activity of *Ps. aeruginosa* "785" was 21,20 % while *Ps. aeruginosa* "1604" 19,39 %. Although the MEOR activities were the same, significant difference between the distributions of oil recovery of the two bacteria strains was observed.

INTRODUCTION

Increasing the capacity of the oil production is one of the most important problems nowadays. The reduced energy of the reserves necessitates the development of several new technologies that fullfil the demand of the growing oil production ([1], [2]). MEOR (Microbial Enhanced Oil Recovery) means microbial methods, for example treatment with biopolymer or biotenside, for improve oil production ([3], [4]).
In recent study we have investigated the possibility of the application of exogenous biopolymer synthesized by two Gram-negative *Ps. aeruginosa* strains in MEOR technology.

MATERIALS and METHODS

Production of bacterial biopolymers

Ps. aeruginosa "785" and "1604" were proliferated in a shaker at 37°C for 24 hour at 180 rpm in Bouillon medium. The biopolymers were produced in modified Bouillon medium at 37°C, which were inoculated with *Ps. aeruginosa* "785" and "1604" grown in Bouillon medium for 24 hour. The final structure of biopolymer was formed after 5 days.

Rheological measurements

Rheological properties of biopolymers were measured by rotational viscometer (Brookfield DV-II+ model) at 37°C. The shear rate (1/s) vs. shear stress (N/m^2) curve was defined flow curve.

MEOR: laboratory measurements

The microbial enhanced oil recovery was examined in a self-made laboratory model system. The instrument is appropriate for the simulation of the pressure, temperature and the flow rate of the reservoir water in the reservoir. After adjusting the residual oil saturation, it is unable to extract more oil from the core. A secondary water injection, after the applying of visco-elastic biopolymer solution, results enhanced oil recovery. We calculated the total and the enhanced oil recovery, and we monitored the pressure difference during the measurement. The measurements run at T=37 °C and P=1 bar.

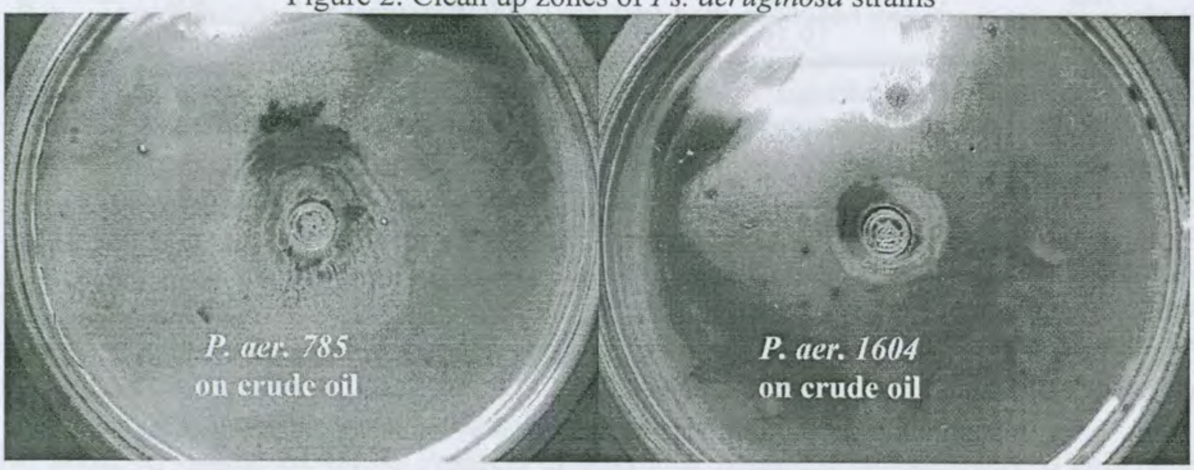
RESULTS

The two *Ps. aeruginosa* strains were able to synthesize the mixture of biopolymer and biotenzide in different effectiveness. Figure 1. shows the culture of the two *Ps. aeruginosa* strains where "1604" proved to be pyocyanin (green pigment) producer strain.

Figure 1. The *Pseudomonas aeruginosa* strain "785" and "1604"

These bacteria have biosurfactant (for example rhamnolipid) producing ability, Figure 2. shows the oil clean up zones of the two strains on crude oil after 168 hours. Results revealed that the strain "785" produce more rhamnolipid than the strain "1604".

Figure 2. Clean up zones of *Ps. aeruginosa* strains



Measurements on programmable Brookfield DV-II+ rotational and Anton Paar oscillatory rheometers proved, that the biopolymer produced by both *Ps. aeruginosa* strains shows viscoelastic behavior and this character is preserved in the diluted form as well. The rheological properties of the biopolymers synthesized by the bacteria strains referred to that exopolymer secreted by "1604" is more stabile and shows higher durability. On the flow curve of the secreted biopolymer of "1604", higher shear stress values can be observed than with "785" (Figure 3.).

Figure 3. Flow curves of biopolymers secreted by different *Ps. aeruginosa* strains

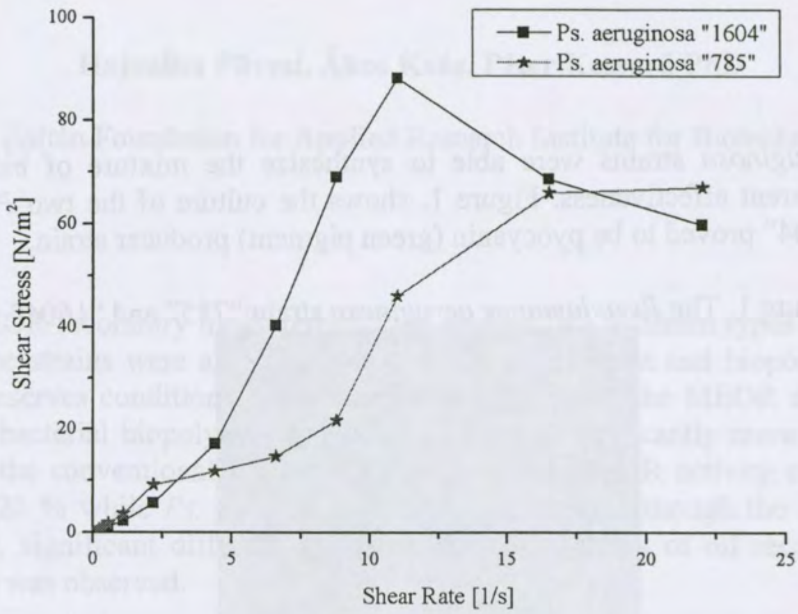
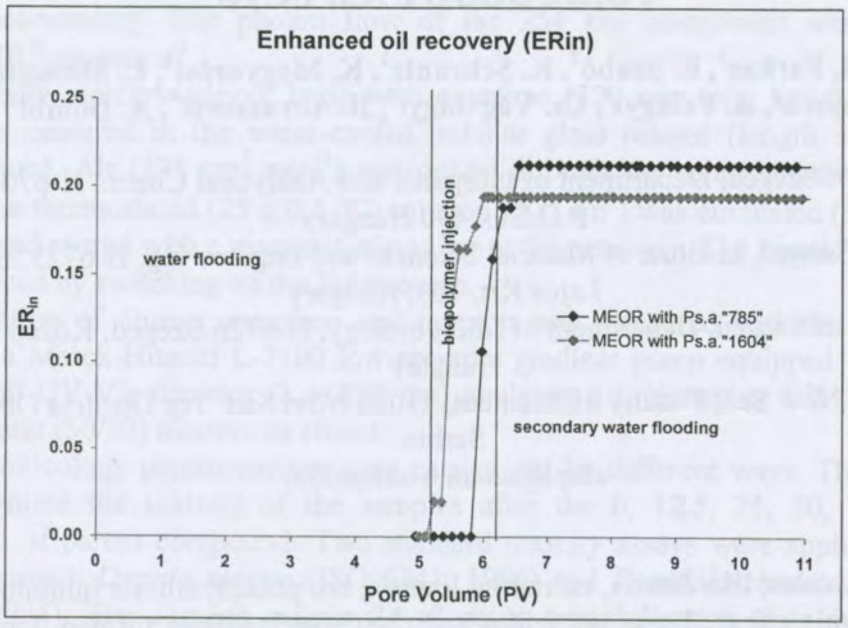


Table 1. Differences between polymer solutions during oil recovery processes

Polymer type	Enhanced oil recovery[%]	Distribution of oil recovery [%]	
		Polymer injection phase [%]	Displacement water injection phase [%]
"785"	21,20	49,98	50,02
"1604"	19,39	100	0

The distribution of the oil recovery differ in situ sub-processes of laboratory MEOR experiments, depending on which bacterial cultures were used in the tests (Table 1.). The results proved that the majority of the recovered oil was detected in the displacement water injection phase in the case of *Ps. aeruginosa "785"*, while the *"1604"* marked polymer showed enhanced oil yield during its injection phase during laboratory MEOR measurements. Laboratory experiments proved that MEOR activity of the strain "1604" was rather biopolymer type, while it was biosurfactant type in case of the strain "785".

Figure 5.



CONCLUSIONS

- We have isolated two *Ps. aeruginosa* strains ("785" and "1604") from oil reservoirs. The strains were able to producing biopolymers and biotenzide in different effectiveness.
- The rheological measurements proved that both produced polymers are visco-elastic gels.
- The results of enhanced oil recovery were very significant in both cases ("785" 21,20% - "1604" 19,39%). Although the MEOR activities were the same significant difference between the distributions of oil recovery of the two bacteria strains was observed.

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