論文 / 著書情報
Article / Book Information

題目(和文)	原油生産井における生物学的サワー化と微生物腐食を制御するための硝酸添加に関する研究
Title(English)	Study of nitrate injection to control biological souring and microbiologically influenced corrosion in crude-oil well
著者(和文)	Kamarisima
Author(English)	Kamarisima
出典(和文)	学位:博士(工学), 学位授与機関:東京工業大学, 報告番号:甲第10972号, 授与年月日:2018年9月20日, 学位の種別:課程博士, 審査員:丹治 保典,中村 聡,和地 正明,山本 直之,八波 利恵
Citation(English)	Degree:Doctor (Engineering), Conferring organization: Tokyo Institute of Technology, Report number:甲第10972号, Conferred date:2018/9/20, Degree Type:Course doctor, Examiner:,,,,
学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
Doctoral Program

論 文 要 旨
THESIS SUMMARY

専攻： Department of	Bioengineering 専攻	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of （工学）
学生氏名： Student's Name	Kamarisima	指導教員（主）： Academic Supervisor(main)	丹治保典
		指導教員（副）： Academic Supervisor(sub)	

要旨（英文800語程度）
Thesis Summary（approx.800 English Words ）

This doctoral dissertation is titled "Study of nitrate injection to control biological souring and microbiologically influenced corrosion in crude-oil well", and consists of seven chapters.

Chapter 1, General introduction. The injection of seawater is commonly used as a method to enhance oil recovery. The high concentration of sulfate (27 mM) in seawater is caused the outbreak of sulfate-reducing bacteria (SRB). SRB is proposed as the main cause of biological sulfide production and microbiologically influenced corrosion (MIC). Several chemical treatments have been proposed to control the growth of SRB, including nitrate injection. The injection of nitrate was aimed to promote the growth of nitrate-reducing bacteria (NRB) which act as SRB competitor for electron donor and oxidized the produced-sulfide. Also, nitrite as the intermediate product could inhibit SRB growth by inhibiting sulfite reductase. However, the application of nitrate injection in this field was inefficient, and further studies were needed to get better results. This study was aimed to investigate the effect of nitrate treatment to control biological souring and MIC using indigenous consortia from oil field water (OFW) and pure culture of SRBs.

Chapter 2, The addition of nitrate to control biological souring. The condition without nitrate addition, *Desulfotignum* (SRB) was dominated in the bacterial community. While in condition amended with nitrate, *Arcobacter* and *Thalassospira* (NRB) became dominant. The addition of nitrate, in condition when the community dominated by *Desulfotignum* did not change the bacterial community, but the produced sulfide was completely oxidized. Based on the variation of nitrate concentration experiment, it revealed that SRB outbreak was observed when nitrate concentration was under 1 mM. Both SRB and NRB share similar hydrocarbon preferences, identified as toluene, ethylbenzene, and xylene.

In chapter 3, The effect of nitrate addition to MIC. In this experimental setup, nitrate added at the concentration of 27 mM at day 0. Without the addition of nitrate, *Desulfotignum* (SRB) still acted as dominant bacteria and contributed to a four-fold increase in general corrosion rate. While in the condition with nitrate addition, the bacterial community was dominated by NRB (*Rhodospirillacea*), and acid-producing bacteria *(Acetobacterium*), which caused pitting corrosion. The general corrosion rate was increased by 8-fold compared to a sterile condition. Moreover, surface roughness analysis of the steel coupon revealed that the addition of nitrate promoted pitting corrosion. Pitting corrosion with shallow depth was observed in the coupon with the rough surface.

In chapter 4, Characterization of two isolated SRB YB01 and YB02 screened from Akita oilfield water. The biological characterization of these isolates has been done using genome-based analysis and culture-based analysis. Based on WGS, it revealed that YB01 and YB02 belonged to *Desulfotignum* genus. These two strains have the complete gene set for toluene degradation, flagellar formation, and sulfate reduction. In addition, only YB01 have the complete set of genes responsible for nitrate reduction into ammonia, while YB02

was only available for reduction from nitrite into ammonia. Based on the culture-based analysis the substrate range of these isolates has only differed in fatty acid utilization.

In chapter 5, The contribution of SRB YB01 and YB02 to cause biological souring and MIC. Higher production of sulfide in both isolates observed when toluene or crude oil was used as the electron donor and carbon source. Based on this study, the nitrate addition was able to control souring and MIC caused by the mixed culture of YB01 and YB02. The YB01 and YB02 were observed to promote MIC by mixed culture and pure independent culture. The YB02 caused more severe pitting corrosion compared to YB01. The ability to switch electron donor from organic carbon to metal iron by YB01 and YB02 was proposed by this study.

In chapter 6, The stress response of YB01 and YB02 against the nitrate-rich environment. Under various nitrate/nitrite concentration, YB01 was more tolerant to nitrate/nitrite while YB02 was more sensitive. Moreover, YB01 and YB02 were also able to switch from heterotrophic growth to chemolithotrophic growth by sulfide-oxidation and nitrate-reduction. The possible switching metabolism from nitrate-reduction to sulfate-reduction was proposed as a defense mechanism of YB01 against nitrate treatment.

Chapter 7, Conclusions and Perspectives. This study revealed that the addition of nitrate could be used to control biological souring but ineffective to control MIC in the environmental sample. The YB01 strain was SRB that can reduce nitrate. The presence of this strain in the environment exposed to nitrate-mediated treatment might be a potential thread to cause ineffectiveness of the nitrate injection because it could disguise as nitrate-reducing, sulfide-oxidizing bacteria. Furthermore, at least 1mM of nitrate were necessary to be detected on production water as the indication of successful nitrate treatment to control SRB.