論文 / 著書情報
Article / Book Information

題目(和文)	多孔質内単相流および混相流における分散
Title(English)	Dispersion in single- and multiphase flow in porous media
著者(和文)	LIZijing
Author(English)	Zijing Li
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12892号, 授与年月日:2024年9月20日, 学位の種別:課程博士, 審査員:末包 哲也,奥野 喜裕,笹部 崇,鈴木 佐夜香,高橋 秀治
Citation(English)	Degree:Doctor (Engineering), Conferring organization: Tokyo Institute of Technology, Report number:甲第12892号, Conferred date:2024/9/20, Degree Type:Course doctor, Examiner:,,,,
学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	要約
Type(English)	Outline

（博士課程）
Doctoral Program

論 文 要 約

THESIS OUTLINE

系・コース： Department of, Graduate major in	機械 エネルギー	系 コース	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of	(Engineering)
学生氏名： Student's Name	LI Zijing		審査員主査： Chief Examiner	末包　哲也	

要約
Thesis Outline

In porous media flow, enhanced diffusion (dispersion) occurs due to the complexity of the pore and the viscous boundary layer. In CCS, dispersion helps the separation, stabilization, and, thus, dissolution of CO2. Therefore, understanding dispersion and its impact factors will help the development of CCS technology.

In single-phase flow, shear flow can be generated due to natural convection caused by density difference, the influence of which remains unknown. In Chapter 2, we investigated the effect of shear flow on single-phase dispersion through experiments using a CT device. Dispersion behaviors of a NaI tracer cloud are investigated under different shear rates ranging from 0.001 to 0.04 s^{-1} and *Pe* ranging from 10 to 200 using an innovative experimental apparatus via an X-ray technique in 2D. In the power-law regime, the dispersion behaviors in the transverse and longitudinal directions are strengthened by shear action, with a larger dependence of the power law on the shear rates and *Pe* compared with that in the uniform flow.

In two-phase flow, trapped oil ganglia create complicated velocity fields even in a steady state, which affects dispersion. We investigated what parameters affect dispersion in two-phase flow within a porous structure through 3D reconstruction experiments in co-flow.

In Chapter 3, the impact of oil viscosity on dispersion in a co-flow is investigated over a large range of fluid viscosity ratios. The results indicate that highly heterogeneous flow fields are generated by a wide distribution of oil clusters with varied volumes. Variation in the velocity distribution enhances the deformation and spreading of a tracer plume, resulting in large dispersion scales and accelerates spreading rates. Anomalous mixing behaviors can be observed when the viscosity ratio exceeds 10 characterized by SDR. These results can be attributed to the fact that the disconnected non-wetting fluid and formed oil film narrows pore spaces and creates more complicated flow fields.

In Chapter 4, the impact of wettability on aqueous dispersion in two-phase flow is studied. We find that wettability greatly affects the pore-scale flow regimes in an immiscible oil-water co-flow and thus impacts dispersion. In a neutral-wet system, pore spaces are intermittently filled with oil and brine which suppresses mixing. In a strong-water-wet system, oil and water only flow through their preferential paths. In water-wet and oil-wet systems, dispersion is strongly enhanced in the flow regime, in which both preferential paths and intermittency contribute to the heterogeneity of velocity fields.