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学位（博士）論文要旨

(Doctoral thesis abstract)

論文提出者 (Ph.D. candidate)	工学府博士後期課程　電子情報工学　専攻 　　　　　　　　　　　　　　　　　　　　(major) 　　　　2017 年度入学(Admission year) 　　学籍番号 17834703　氏名　董　冠強(DONG GUANQIANG) (student ID No.)　　　　　(Name)
主指導教員氏名 (Name of supervisor)	鄧　明聡
論 文 題 目 (Title)	Operator & fractional order-based robust nonlinear control for the spiral heat exchanger オペレータと分数次に基づくスパイラル熱交換器に対するロバスト非線形制御

論文要旨（2000 字程度）
(Abstract (400 words))

ABSTRACT

This dissertation provides operator & fractional order-based nonlinear robust control for the spiral heat exchanger with uncertainties and disturbances described by the fractional order model. Under disturbances, the aim of this dissertation is to guarantee the robust stability, tracking performance and anti-disturbance ability of the spiral heat exchanger with uncertainties.

The spiral heat exchanger is a compact plant that only requires a small space for installation compared to traditional heat exchanger solutions and is excellent in high heat transfer efficiency. However, the spiral heat exchanger is a nonlinear plant with uncertainties and it needs to consider the difference between the heat medium, the heated medium and the other factors. In some applications, the output temperature of heated or cooled fluid for the heat exchanger must be controlled accurately. Because the heat transfer coefficient is impacted by various factors such as fluid flow, condition pressure, the uncertainties, the error of the mathematical model, and a long-time delay, etc., it is difficult to accurately model and control the output temperature of the heat exchanger.

Firstly, a parallel fractional order derivative model is proposed by considering the merit of the graphics processing unit (GPU) in this dissertation. The parallel fractional order derivative model for the spiral heat exchanger is constructed. Simulations show the relationships between the output temperature of heated fluid and the orders of fractional order derivatives with two directional fluids impacted by complex factors, namely, the volume flow rate in hot fluid, and the volume flow rate in cold fluid, respectively. Secondly, this dissertation studies operator & fractional order based nonlinear

robust control for the spiral counter-flow heat exchanger with uncertainties under disturbances. Operator fractional order controller and fractional order PID (FOPID) controller are designed and some parameters are tuned by trial-and-error method. Simulations verify tracking and anti-disturbance performance by comparison of different control cases. Finally, operator based nonlinear robust control for the spiral heat exchanger described by a parallel fractional order model is proposed. The parallel fractional order model for the spiral heat exchanger is identified by particle swarm optimization (PSO). FOPID controller and operator controller for the spiral heat exchanger are designed under parallel fractional order mathematical model. The parameters of FOPID controller are optimized by PSO. Comparisons of two control cases are performed, and the effectiveness is illustrated.

（英訳）※和文要旨の場合(400 words)