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基于航空排放的机场停机位分配优化

周晓宁[1] 王 凯[2,3] 赵志奇[2,3] 李 杰[2,3*]

(□京航□航天□□□□□院[1],民航□院[2],□□□□飞□□□□□□□□□□[3],□京 211106)

摘 要 □□航空□□快速□□,航空排放□□气环境□□□日益严□。□场停□位□□优□□□,□航空绿色□□具□□□意义。□□场□□□□□,航空器排放、近□位□□率□多目□,□□一种使航空器排放□□□,近□位□□率□□□□场停□位□□优□□□,□□□南京禄口国际□场某日航班□据□□□证。□果表明:由□近□位□□率□□升,航空器□HC、NO_x、CO、SO_x□颗粒□(particulate matter,PM)排放□□别□少 12.33%、7.81%、12.66%、11.06%□ 11.17%;地□保障□备(ground support equipment, GSE)□ HC、NO_x、CO、PM 排放□□别□少 9.59%、4.63%、14.34%、13.64%;远□位旅客平均花费时□□少 42.31%。可见□□□优□□□增加□近□位□□率,□少□□场航空排放,□少□远□位旅客平均花费时□,□证□□□□□□。

关键词 □场 航空排放 停□位□□ 多目□优□

中图法分类号 V 351.11 X 831; **文献标志码** B

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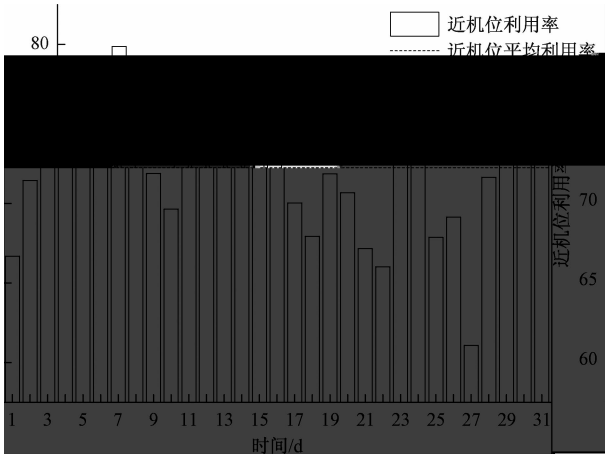

图 1　南□禄口国□机场 10 月份□机位利用率

Fig. 1　The utilization rate of contact gate at Nanjing Lukou International Airport in October

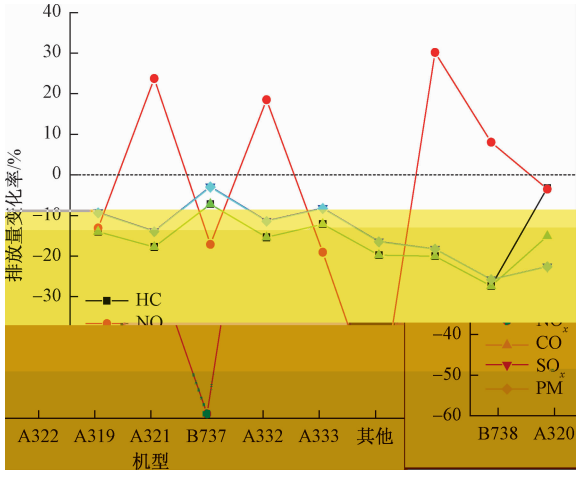

图 2　不同机型污染□排□量变化率

Fig. 2　Variation rate of Emissions from different aircraft

使用优化后□机位分□方案，□空器 HC、NO_x、CO、SO_x 和 PM

的实际运行特点，构建了多目标停机位分配优化模型，并以南京禄口国际机场为研究对象进行实例验证。得到以下结论。

（1）优化后停机位方案比优化前的方案，航空器的 HC、NO_x、CO、SO_x 和 PM 排放量分别减少 12.33%、7.81%、12.66%、11.06% 和 11.17%；GSE 的 HC、NO_x、CO、PM 排放量分别减少 9.59%、4.63%、14.34%、13.64%；远机位旅客平均花费时间减少 42.31%。

（2）提出的优化模型提高了近机位利用率，减少了机场航空排放和远机位旅客平均花费时间，验证了模型有效性。

未来研究中，可结合考虑场面滑行路径、滑行方式优化等其他场面减排方法，确定安全、高效、环保的机场停机位分配方法，更好地促进机场绿色发展。

参 考 文 献

1 国家发展和改革委员会，中国民用航空局. 全国民用运输机场布局规划[M]. 北京：国家发展和改革委员会，中国民用航空局，2017
National Development and Reform Commission, Civil Aviation Administration of China. Full national transport airport layout planning [M]. Beijing: National Development and Reform Commission, Civil Aviation Administration of China, 2017

2 Federal Aviation Administration Office of Environment and Energy. Aviation emissions and air quality handbook Version 3 Update 1[M]. Washington: FAA, 2016

3 ICAO. Airport local air quality guidance manual[M]. Montreal: International Civil Aviation Organization. 2007

4 Yang W, Omaye S T. Air pollutants, oxidative stress and human health. [J]. Mutation Research, 2009, 674(1):45-54

5 Schlenker W, Walker W R. Airports, air pollution, and contemporaneous Health[J]. Nber Working Papers, 2016, 83(2), 768-809

6 Senkayi S N, Sattler M L, Rowe N, et al. Investigation of an association between childhood leukemia incidences and airports in texas[J]. Atmospheric Pollution Research, 2014, 5(2), 189-195

7 Winther M, Kousgaard U, Ellermann T, et al. Emissions of NO_x, particle mass and particle numbers from aircraft main engines, APU's and handling equipment at Copenhagen Airport[J]. Atmospheric Environment, 2015, 100(5):218-229

8 Dell'Orco M, Marinelli M, Altieri M G. Solving the gate assignment problem through the fuzzy bee colony optimization[J]. Transportation Research Part C Emerging Technologies, 2017, 80(3):424-438

9 Yu C, Zhang D, Lau H Y K. An adaptive large neighborhood search heuristic for solving a robust gate assignment problem[J]. Expert Systems with Applications, 2017,32(4) 84-90

10 苏 原，何秋钊. 基于混合粒子 算法的机场停机位优化分配问题研究[J]. 中国民航飞行学院学报，2013,10(1):24-28
Su Yuan, He Qiuzhao. Airport gate assignment optimization based on Hybrid particle swarm algorithm [J]. Journal of Civil Aviation Flight University of China, 2013,10(1):24-28

11 Castaing J, Mukherjee I, Nguyen A, et al. Reducing airport gate blockage in passenger aviation [J]. Computers & Operations Research, 2016, 65(8): 189-199

12 Sang H K, Feron E. Robust gate assignment against gate conflicts [J]. AIAA,2017, 25(1):1-8

13 刘长有，郭 楠. 基于运行安全的停机位分配问题研究[J]. 中国安全科学学报，2011, 21(12):108-114
Liu Changyou, Guo Nan. Research on gate assignment for aircraft based on operational safety [J]. China Safety Science Journal, 2011, 21 (12):108-114

14 Tang C H, Wang W C. Airport gate assignments for airline-specific gates [J]. Journal of Air Transport Management, 2013, 30(7):10-16

15 Maharjan B, Matis T I. Multi-commodity flow network model of the flight gate assignment problem[J]. Computers & Industrial Engineering, 2012, 63(4):1135-1144

16 刘君强，陈鹏超. 基于航空公司飞机滑行油耗均衡原态的机场停机位分配算法[J]. 价值工程，2012, 31(16):3-4
Liu Junqiang, Chen Pengchao. The gate assignment based on balanced fuel consumption of aircraft taxiing of airline[J]. Value Engineering, 2012, 31(16):3-4

17 Evertse C, Visser H G. Real-time airport surface movement planning: minimizing aircraft emissions [J]. Transportation Research Part C Emerging Technologies, 2017, 79(3):224-241

18 张红飞. 航空器低排放场面滑行策略研究[D]. 天津：中国民航大学，2017
Zhang Hongfei. Research on the strategy of aircraft low emission taxiing on the airports[D]. Tianjing: Civil Aviation University of China, 2017

19 Guo R, Zhang Y, Wang Q. Comparison of emerging ground propulsion systems for electrified aircraft taxi operations[J]. Transportation Research Part C, 2014, 44(32):98-109

20 李 楠，张红飞. 航空器场面滑行污染物排放计算研究[J]. 环境科学学报，2017, 37(5):1872-1876
Li Nan, Zhang Hongfei. Calculating aircraft pollutant emissions during taxiing at the airport[J]. Acta Scientiae Circumstantiae, 2017, 37(5):1872-1876

21 万莉莉. 面向环境保护的空中交通运行优化方法研究[D]. 南京：南京航空航天大学，2015
Wan Lili. Research on the optimization method of air traffic operation for environmental protection[D]. Nanjing: Nanjing University of Aeronautics and Astronautics, 2015

22 US EPA. User's Guide for the final NONROAD 2005 model and EPA NONROAD model updates: EPA420-R-05-013 [R] Washington: EPA, 2009

23 Bouras A, Ghaleb M A, Suryahatmaja U S, et al. The airport gate assignment problem: A survey[J]. The Scientific World Journal, 2014, 14(6):9165-9172

24 中国民用航空局. 民航局航班正常统计办法（2016 征求意见）[M]. 北京：中国民用航空局，2016
Civil Aviation Administration of China. CAAC flight normal statistical measures (2016 comments)[M]. Beijing: Civil Aviation Administration of China, 2016

25 崔 涛. 基于粒子 算法的不确定动 多目标优化方法研究[J]. 科学技术与工程，2017, 17(15):115-119
Cui Tao. Based on particle swarm algorithm of uncertain dynamic

multi-objective optimization method research[J]. Science Technology and Engineering, 2017, 17(15):115-119

26 贺　莉，刘庆怀. 多□标□化理论与连□化方□[M]. 北　京：科学出　　，2015
He Li, Liu Qinghuai. Multi-objective optimization theory and continuous method [M]. Beijing: Science Press, 2015

27 中国　用航□□发展计划司. 2017 年　航□□□□统计公□[M]. 北　京：中国　用航□□,2018
Civil Aviation Administration of China Development Planning Division. 2017 civil aviation airport production statistics bulletin[M]. Beijing: Civil Aviation Administration of China, 2018

28 中国　用航□□. 　用□□飞行　技术标□：MH 5001—2013[S]. 北　京：中国　用航□□, 2013
Civil Aviation Administration of China. Civil airport flight zone technical standard: MH 5001—2013[S]. Beijing: Civil Aviation Administration of China, 2013

Optimization of Gates Assignment Based on Air Emissions

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[**Abstract**] With the development of aviation industry, the impact of air emissions on the atmospheric environment is becoming more serious. The study on optimization of airport gates allocation is of great significance to the development of greener aviation. The optimal model was established to minimize aircraft emissions and maximized contact gates utilization based on operation rules, aircraft emissions, utilization rate of contact gate and other objectives. The verification of flight data on a certain day at Nanjing Lukou International Airport shows that: the HC, NO, CO, SO_x and particulate matter (PM) from aircraft are reduced by 12.33%, 7.81%, 12.66%, 11.06% and 11.17% respectively due to the improvement of near-seat utilization rate, and the HC, NO_x, CO and PM emissions of ground support equipment (GSE) are reduced by 9.59%, 4.63%, 14.34% and 13.64%, respectively. The average time spent by passengers to remote gate decreases by 42.31%. The proposed optimization model increases the utilization rate of contact gate, reduces air emissions, and average time spent by passengers and the model is verified.

[**Key words**] airport　　aviation emissions　　gate assignment　　multi-objective optimization

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