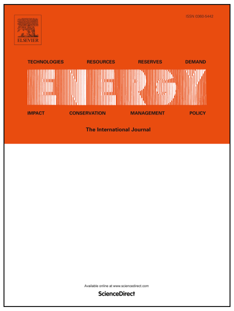

# Design of cylindrical mixing chamber ejector according to performance analyses

Wei Lu, Hongjie Chen

PII: S0360-5442(18)31785-7

DOI: 10.1016/j.energy.2018.09.025

Reference: EGY 13719

To appear in: *Energy*

Received Date: 24 April 2018

Revised Date: 2 September 2018

Accepted Date: 4 September 2018

Please cite this article as: Lu W, Chen H, Design of cylindrical mixing chamber ejector according to performance analyses, *Energy* (2018), doi: 10.1016/j.energy.2018.09.025.

# Design of Cylindrical Mixing Chamber Ejector According to Performance Analyses

**Wei Lu** [a], **Hongjie Chen** [b,*]

[a] *College of Mechanical Engineering, Guangxi University, Nanning 530004, Guangxi, China*

[b] *School of Energy and Building Environment, Guilin University of Aerospace Technology, Guilin 541004, Guangxi, China*

**Abstract**：A design method for cylindrical mixing chamber ejector according to performance analyses is proposed based on the real gas properties. Compared with the experimental data, the entrainment ratio and critical back pressure calculated by the proposed method have errors within ±17% and ±6%, respectively. Ejectors with common characteristic sizes using steam, ammonia, R290 and R134a as working fluids are analyzed by this method. Consequently, design curves and regressive expressions are provided to describe the relations between entrainment ratios, ejector area ratios and expansion and compression ratios, as well as the relations between nozzle area ratios and expansion ratios. The expressions of nozzle throat areas are regressed for steam ejectors at 75~130℃, as well as for ammonia, R290 and R134a ejectors at 75~95℃. The design curves and regressive expressions provided by this paper can be used to design ejectors with cylindrical mixing chamber accurately and conveniently.

**Key words:** ejector; analysis; design; fluid dynamics; real gas properties

## 1 Introduction

Vapor ejector, the device that can use high-pressure vapor to boost low-pressure one, is widely used in low-grade thermal energy utilization purposes [1-2]. Two types of mixing chamber are available in ejector design, which are conical or cylindrical corresponding to design conditions with large or small compression ratio, respectively. In fact, the efficiency is often low at condition of large compression ratio, leading to the poor performance. Thus, the ejector with cylindrical mixing chamber is more often applied in the ejector refrigeration system [3-5].

On the design of ejector with cylindrical mixing chamber, Keenan et al. put forward the earliest design theory, but the theory could not match experiment well due to the neglect of entropy generation in the ejector [6]. Addy et al. derived the relationship between the entrainment ratio and the area ratio of ejector by introducing the nozzle efficiency and diffuser efficiency [7]. Sokolov et al. adopted aerodynamic functions to propose the design method for cylindrical mixing chamber ejector [8]. These early design methods were all based on ideal gas hypothesis and not reliable enough. Thus, the real gas hypothesis was considered by Khalil et al. to make the theory more accurate [9].

On performance analysis of cylindrical mixing chamber ejector, Huang et al. put forward a one-dimensional theory verified by a large number of experiments [10]. Zhu et al. proposed a simplified calculation method based on critical circle hypothesis [11]. Chen et al. established an entrainment ratio calculation method for ejector working at single or double chocking modes [12]. In addition to the models with ideal gas hypothesis, there are still several real gas properties models. Cardemil et al. introduced the single- and two-phase calculation methods of sound speed in the calculation of entrainment ratio at double chocking mode [13]. Chen et al. established calculation method for entrainment ratio at single and double chocking modes based on real gas hypothesis [14]. Saleh et al. realized the performance analysis on a variety of HFCs and HCs refrigerant ejectors by introducing BACKONE state equation into the model [15]. Compared with ejector performance analysis, researches on the design theory are not thorough because the structure and operating parameters are one-to-one for a reasonably designed ejector, making it inconvenient to verify the design theory by changing the structure. However, once an ejector analysis theory is put forward, it can be conveniently verified by the published experimental data or by changing the operating conditions. This results in the accuracy of the performance analysis theory higher than that of design theory.

For engineering application of ejector, the design method is more significant than the performance analysis one. In fact, the design and the performance analysis complement each other, which means the design parameters can be

---

*Corresponding author.
E-mail address: capricorn1987@126.com (Chen Hongjie).