International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 04 | Apr 2021 www.irjet.net p-ISSN: 2395-0072

A REVIEW ON JET EJECTOR SYSTEM

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Abstract - *Jet ejectors are the simplest devices between all compressors and vacuum pumps. They do not contain any moving parts, lubricants or seals, and are therefore considered to be the most reliable devices with low supporting costs. In addition, most jet ejectors use steam or compressed air as a motive fluid, which is readily available in chemical plants. They are widely used in the chemical industry processes; however, jet ejectors have low efficiency. Many factors affect the performance of a jet ejector, including molecular fluid weight, feed rate, tube length mixing, tube area, throat size, fluid speed, Reynolds number, pressure rating, and temperature range. This paper reviews various studies with jet ejector for different performance.*

Key Words: **Steam Jet Ejector, Mach Number, Nozzle, Motive Fluid, Mass Transfer.**

1. INTRODUCTION

Jet ejectors are broadly used in the chemical industries because of their simplicity. In many cases, they offer a great option for vacuum production in processes. They are found in variety of sizes. Because of their simplicity, conventional jet ejectors are well designed in a given situation that are highly forgiving of errors with a limited volume and performance.

1.1 Operating Principle of Jet Ejector

As shown in the Figure 1, the jet ejector design has four major section:

1. Nozzle 2. Suction Chamber 3. Throat 4. Diffuser

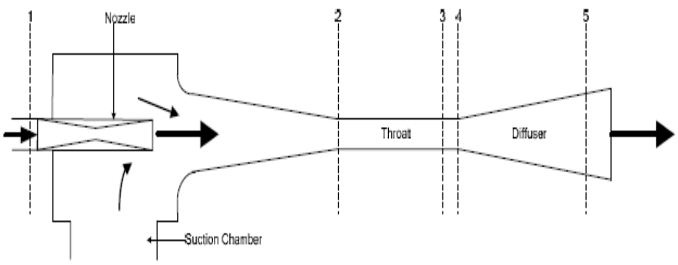

Figure 1. Jet Ejector Design

The operating principle of ejectors is described below:

1. At Point 1, subsonic motive fluid enters then nozzle. In the converging section of nozzle, the stream velocity increases and the pressure reduces. The stream reaches its sonic velocity at the nozzle throat. The increase in cross sectional area at the diverging section of the nozzle decreases the shock wave pressure and its velocity increases to supersonic velocity.
2. At Point 2, the entrained fluid enters the ejector where there is increase in velocity & reduction in pressure.
3. The motive fluid and the entrained fluid mix within the suction chamber and the converging section of diffuser or they both mix together in throat section.
4. In the throat section, there is generation of shock wave. Reduction in the mixture velocity to a subsonic condition and the back pressure resistance of the condenser results in shock wave at Point 3.
5. As the mixture flows into the diverging section of diffuser, the kinetic energy of the mixture is transformed into pressure energy.

There can be different purposes for ejector construction such as:

1. For greater penetration into the second liquid.
2. Producing a large mix between two liquids.
3. Pumping fluid from low pressure region to high pressure region.

2. LITERATURE REVIEW

Arth R. Patel [1] concluded that the results obtained through the analysis show that by reducing the steam inlet pressure, the outlet pressure condition remains the same, and therefore the efficiency of the refrigeration plant is improved because less energy is required to generate motive steam pressure and temperature.

T. Aravind [2] employed Spallart-Allmaras turbulence model which is able to predict the operating feature of steam ejector. Entrainment (ER) ratio has been found to increase with boiler saturation temperature reduction of the same superheat condition, evaporator temperature and condenser pressure. The shocking position was found to recede as the condenser pressure increased. Entrainment rate was found to increase with decreasing throat width. It resulted in the moving downstream of the shocking position because of the reduction in the mass of primary fluid.

Natthawut Ruangtrakoon [3] compared experimental result with CFD. The mixing process inside the ejector were explained using Mach number contour lines. It was thereby concluded that the position of shock and angle of expansion of the motive fluid stream played a vital role in the performance of ejector.

Szabolcs Varga [4] determined efficiency of the ejector for the first time using an axi- symmetric CFD model. Working fluid was taken as water Results show the existence of an appropriate rating, depending on the operating conditions. Ejector efficiency was calculated for different operating conditions. It has been found that although the efficiency of a nozzle can be considered permanent, the efficiency associated with suction, mixing and diffuser ejector components depends on operating conditions.

Xianchang Li et al. [5] performed a statistical analysis to study the effect of geometric order on the performance of a steam ejector used in conjunction with a steam evaporator. It is clear that any resistance to the downstream will significantly affect the flow rate. In addition, the entrainment rate is sensitive to jet discharge, and there is a good point where the main flow should be discharged.

Natthawut Ruangtrakoon et al [6] used the CFD process to investigate the effect of the main pipe geometry on the performance of the ejector. In all cases, only one fixed geometric mixing chamber and eight separate nozzles were investigated numerically using a CFD commercial package. The use of the CFD method was divided into two main components; creating a visual model (calculating domain) and solving a set of mathematical calculations. Commercial software package, Gambit 2.3 was used to create the model.

Szabolcs Varga et al. [7] considered in their work the influence of geometric features on the operation of steam jet ejector. Opinion analysis was performed with the CFD model of the steam ejector using FLUENT. The results indicated the existence of a suitable local scale, depending on the operating conditions. In the present case, they considered axi-symmetry. The active relationship between the three major unknown factors - temperature (T), pressure (p) and velocity vector (v) - defines the pressure flow of the isotropic Newtonian fluid, provided by energy conservation, momentum and continuous equilibrium, in the form of a set of differential ratios (PDE).

Natthawut Ruangtrakoon [8] investigated Jet refrigerator test setup. 1 kW cooling refrigerator was built and tested. The system is tested with different operating temperatures and a different nozzle. Boiler saturation temperature is rated from 110 to 150 ° C. Six tubes have a throat diameter ranging from 1.4 to 2.6 mm with an output value of Mach number 4.0. The remaining two tubes have the same diameter of 1.4 mm but the difference is from the number Mach 3.0 and 5.5. Experimental results show that the geometry of a main nozzle has a significant impact on the performance of the ejector and therefore the COP system.

Kang Guanqun and Wang Qiang [9] studied to improve the geometric shape of the nozzle ejector pipe, an integrated probe calculation of the flow field and the robust heat applied to the pipe were performed and presented in this paper. A finite volume method was used to solve Navier-Stokes equations. Accurate fluxes calculations, dissipation losses in the shear layer and complete non-preservative enthalpy beyond severe shocks can be eliminated with the help of the modified Reimann Roe scheme while adjustment for shock condition and entropy condition is satisfactory. The variability is assessed by a centralized separation scheme that can eliminate uneven or deteriorating methods. The passage of time is done using the uninstalled LUSGS method with multigrid acceleration.

G. Saidulu [10] modeled steam ejector changing with different nozzle diameters and Analyzed the steam ejector with different mass flow rates to determine the pressure drop, Mach number, velocity and heat transfer rate for the motive fluid by CFD. By looking at the CFD analysis of Mach number, decrease in pressure, heat transfer rate and weight flow rate increase by increasing the size of the nozzle and the condenser pressure. Therefore, it can be concluded that the steam ejector nozzle diameter 2.6mm is the best model.

3. CONCLUSIONS

1. The Jet ejector system has a variety of operating features with different functions. The main application is refrigeration and air conditioning
2. The initial design of the pipe, the outlet area of the pipe, the effective mixing area, the back pressure in the diffusor, the Fluid velocity, the pressure measurement and the specific temperature range apply to the operating parameter.
3. Their use as bulking machines for liquid extraction - liquids, gas absorption, gas extraction, mass transfer, slurry reaction such as hydrogenation, oxidation, chlorination, fermentation, etc.

4. FUTURE SCOPE

For the researchers there is a wide range of analysis and design of a new jet ejector model for mass transmission and other vacuum construction and installation of mixing application & a lot of work has to be done on the jet ejector of the multi-nozzle.

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