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Effect diameter of throat 8, 7 mm in improving performance liquid jet gas pump

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Abstract
Liquid jet gas pump (LJGP) is device that can harness the flow air and water in the vacuum process. This Liquid jet gas pump in the working process without use of moving parts so that construction becomes simple and easily obtained in the process of design and installation instrument setup. In Liquid jet gas pump system consists of main and supporting equipment that section chamber, nozzle, throat, diffuser, pipe, elbow, tranquilizers tube and pump. To increase the performance Liquid jet gas pump necessary to experiment with modifying some the major equipment that are considered to affect the performance Liquid jet gas pump. In these experiments carried out modification namely throat dimensions throat diameter, where one of the main equipment is necessary to get special attention because of throat occur in continue process and laminar flow, before eventually into the diffuser either turbulent or laminar. The purpose of research is to improve the performance Liquid jet gas pump in vacuum process. The research method with experiments involving water fluid and air in the area ratio of 0.67, throat diameter of 8.7 mm and throat length 39,15mm. The observed data is primary flow or motive flow that is 6, 7, 8, 9, 10 GPM and secondary flow is 5-30 scfh. While for the water to circulate fluid Liquid jet gas pump, use of centrifugal pumps. The results showed that throat 8,7 mm diameter and 39.15 mm throat length, a phenomenon that occurs is the increased flow rate that causes a decrease in ratio of pressure so the flow rate decreases motive, and while variation the liquid discharge can affect the efficiency of the resulting namely, with variations in discharge liquid or motive flow (6, 7, 8, 9 and 10 gpm) and the gas discharge is 0 -30 scfh, it was found the vacuum pressure that is 6 gpm = 94.7025 kPa, 7 gpm = 96.95 kPa, 8 gpm = 93.91 kPa, 9 gpm = 89.67 kPa, 10 gpm = 87.02 kPa while the highest efficiency is obtained in the discharge liquid 6 gpm is equal to 16.82%. Discharge motive of the higher tend to provide better efficiency at all levels of flow ratio.

Keywords: Throat, LJGP, nozzle, liquid, performance

1. Introduction

Liquid jet gas pump (LJGP) is a device that can harness the flow of air and water in a vacuum process. The equipment in the working process without the use of moving parts so that construction becomes simple and easily obtained in the process of design and installation. Liquid jet gas pump an ejector type vacuum pump which functions generate vacuum gas (pressures below atmospheric pressure). In liquid jet gas pump systems influence flow ratio the pressure ratio is very important to know, because in these conditions can determine the level of efficiency of liquid jet gas pump. To increase the performance liquid jet gas pump necessary to experiment with modifying some of the major equipment that are considered to affect the performance liquid jet gas pump.

In the experiments carried out modification namely throat dimension throat diameter, where one of the main equipment is necessary to get special attention because of the throat occur in continue process and laminar flow, before eventually into the diffuser either turbulent or laminar. Efficiency Liquid jet gas pump is the amount of the work produced divided by the incoming energy, with: η = efficiency, in these ϕ= flow ratio of air to water, P_G = air or gas pressure, Pd = the pressure at the downstream end of the diffuser, Ps = pressure in the suction chamber, and Pi = pressure primary flow. The parameters used in this study to certify the performance of performance is the efficiency of liquid jet gas pump to the size of the non - dimensional system, the ratio of secondary and primary flow capacity (QG / QL).

$$\eta = \frac{P_G \phi \ln(P_d/P_s)}{(P_i - P_d)} \quad \ldots. (1)$$

Liquid jet gas pump design consists of four main parts: throat, nozzle, suction chamber and diffuser. Throat is a place where the process of changing the pattern of the jet stream to froth flow, the pressure increases, and slowing the flow rate, so that the dimensions of throat can affect performance at liquid jet gas pump.

In some of the Research which have been done Tony suryo utomo, 2011 on the simulation process ejector X with throat diameter of 2.64 mm and area ratio of 2.3. The simulation results also show that larger diameter of throat, value of the steam ejector entrainment ratio becomes lower, conditions certainly affect performance of the tool.

Eswanto, Murniaty 2015 [3]. in experiments liquid jet gas pump performance on 30.45 mm length throat explains that the throat length of 30.45 mm, an increase in flow rate causes a decrease the ratio of pressure so that the flow rate decreases motive, and by varying the liquid discharge can affect the efficiency which resulting. The highest efficiency obtained at 6 gpm (gallon per minute) liquid discharge that is equal to 10.543% with the vacuum level achievement of 85.828 kPa.

Witte, (1969) in his research said that the throat occur inverse gas flow patterns that continue into liquid continue. This pattern changes caused by the exchange of momentum between the flows. At any particular condition where the inflow throat supersonic speed after mixing speed drops to

subsonic, then at this speed change transition will happen phenomenon of mixing shock. On the other side of jet pump efficiency can be affected by the end laying distance nozzle and inlets mixing throat. Jet pump maximum efficiency occurs at space nozzle-mixing throat 16 mm. increased efficiency of jet pump to obtain optimum results continue developed, one through research to optimize the throat as one of main equipment, (Bahtiar, 2008) [1].

Iciek (1982) [5]. Tested the effect of Reynolds number on the length jet with variant aspect ratio. The indicators used in this exsperiment is a length jet can be achieved by a nozzle against Reynold number. Based on the Weber number nozzle having a smaller aspect ratio tend to have higher Weber numbers. Weber numbers are higher due to the lower flow resistance so that the faster flow on the nozzle with a low aspect ratio.

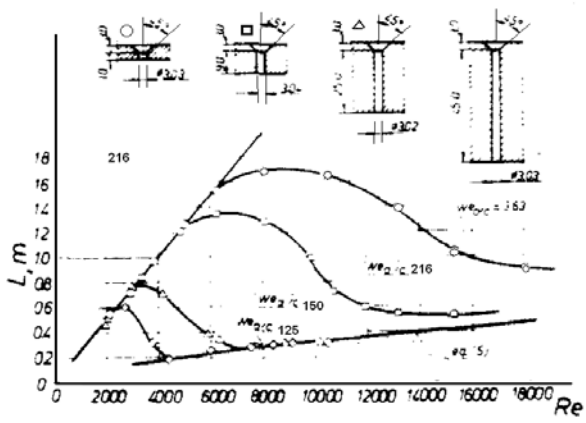

Fig 1: Effect aspect ratio to length of jet. (Iciek, 1982) [5].

The purpose of this research is to improve the performance Liquid Jet Gas Pump (LJGP).

2. Experimental Setup and Procedure

This research method is done whith experiment, using water fluid and air with a throat diameter of 8.7 mm, the area ratio of 0.65 and throat length 39, 15 mm. While observed data is the primary flow / motive flow that is 6, 7, 8, 9, 10 GPM and discharge secondary flow 5-30 SCFH (Standart Cubic Feed Hours). In this research the fluid to circulate water to liquid jet gas pump, used centrifugal pump with capacity 340 L/min (400 watt). In this research using liquid jet gas pump installation circuits, as shown in Figure.2 below along with the measuring instrument. In this research geometry used to create liquid jet gas pump is maximum geometry of each component collected from a variety of different research.

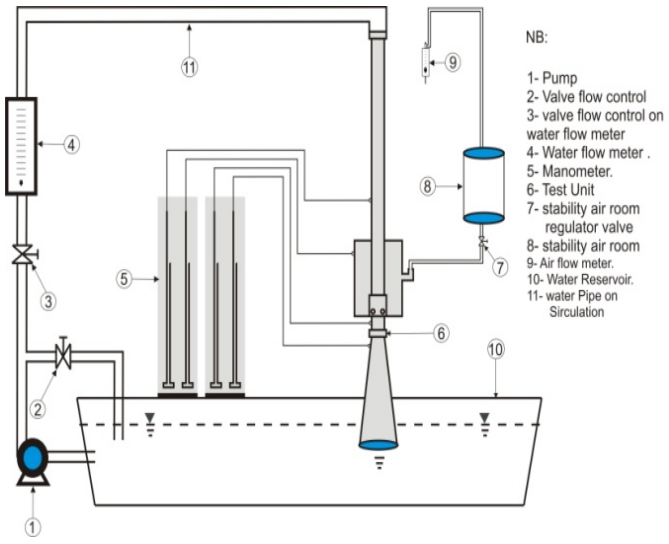

Fig 2: Schematic Installation liquid jet gas pump

Fig 3: The test model

In conducting this research data collection process in experiments carried out using several measuring instruments, which are: to measurement the pressure made by two kinds of pressure gauge mounted on the test installation, that is: Bourdon manometer and manometer tube 'U'. Bourdon manometer used to measurement the static pressure on the primary side, the secondary side, and side dischard. Manometer type which is used for three types measurements are divided into two. Pressure manometer Positive to measurement the pressure of primary side and the side discard and negative pressure manometer or vacuum is used to measurement the secondary side. While the tube manometer 'U' used to measurement the pressure along the throat. This instrument using a fluid medium mercury. Data results of these measurements can be done direct reading. In addition to the two measuring devices that have been

mentioned, it is also used as a regulator rotameter liguid flow rate, as well the air flowmeter to get vacuum and the thermometer used a measurement of fluid temperature.

Table 1: Experiment Conditions

Conditions	data
Throat diameter, d_T = 8.7 mm Throat length, L_T =4.5 (mm)	4.5d_T or 39,15 mm
Motive discharge/motive flow (GPM)	6, 7, 8, 9 and 10
Secondary flow (SCFH)	0 - 30

The method of collecting data during experiments performed with varying pressure on the motive, secondary, and discharge flow in liquid jet gas pump with using throat diameter 8.7 mm and 39, 15 mm throat length. Changes done by adjusting the flow pressure water flow and the air coming out of flowmeter. Parameter experiments and experimental variation data shown on Table.1

3. Results and discussions

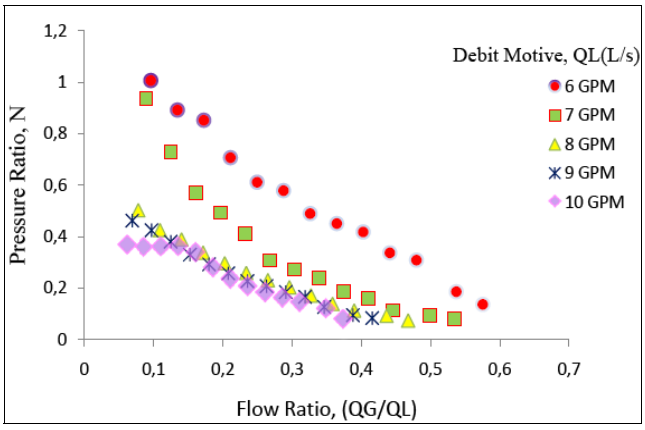

Fig 4: Chart relationship Flow Ratio Against Pressure Ratio with a throat diameter of 8.7 mm and 39.15 mm throat length.

The results of the research that has been done by taking data while processing, that is throat diameter of 8.7 mm and length of 39.15 mm with variation throat discharge liquid / motive (6, 7, 8, 9, 10 gpm), while the gas discharge is 0 - 30 SCFH (Standard Cubic Feed Hour. The complete figure.4 data obtained that is on 6 gpm = 94.7025 kPa, 7 gpm = 96.95 kPa, 8 gpm = 93.91 kPa, 9 gpm = 89.67 kPa, 10 gpm = 87.02 kPa.
From the test results and data processing, as shown in Figure 4, that is relations flow ratio against the pressure ratio, a tendency on any given motive discharge phenomena form not much different from the other motive discharge. The phenomenon shown in Figure 4 that increasing flow ratio causes decrease in pressure ratio so that the impact speed motive flow also decreased. The reduced flow rate this motive causes vacuum pressure decreases and increases motive pressure (the pressure ratio decreases). Therefore modifications affect the performance liquid jet gas pump throat dimensions, which have an impact on the resulting vacuum equipment's liquid jet gas pump.

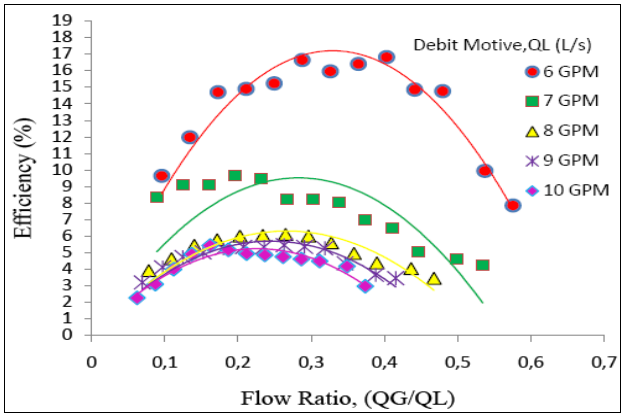

Fig 5: Chart flow ratio to efficiency

On the other side of phenomenon occurring in figure 5 shows the relationship flow rate based on efficiency pursuant to change motive flow. The motive flow high tends to give better efficiency at all levels of flow ratio. Efficiency decreased in all variations motive flow to decrease the flow rate, which figure 5 shows that maximum efficiency in the discharge of motive 6 gpm amounted to 16.82 % at 21 SCFH (0.165 L / s) with degree of vacuum reached 80.398 kPa. While the motive flow 7,8,9,10 gpm each obtained was 9.65 %, 11 scfh (0.086 L / s), 80.39 kPa, and 6.10%, 17 scfh (0.133 L / s), 80.79 kPa, and 5.45%, 19 scfh (0.149 L / s), 76.29 kPa, while for motive flow 10 gpm obtained equal to 5.16 %, 15 scfh (0.118 L / s), 58,41 kPa.
In general the results obtained from testing throat diameter of 8.7 mm and throat length of 39.15 mm showed the same pattern, then at some point it will reach its maximum level, and can be called with maximum efficiency liquid jet gas pump. In figure 5 above also explains that gas and liquid flow variations affect the pressure ratio on the tool liquid jet gas pump, this is phenomenon can be seen from the graph with the resulting optimum conditions are not the same. Vacuum on the tool liquid jet gas pump can be achieved to certain extent by increasing the discharge gas and liquid are provided.

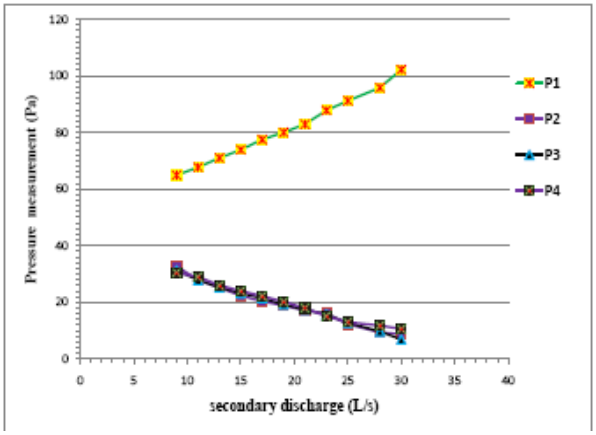

Fig 6. Chart secondary discharge to pressure measurement.

In figure 6 are the readings in the measurement of the pressure and the secondary discharge, where these conditions produce stable phenomenon, the graph shows the increase or decrease that occurred at standard conditions. This means that whenever there is an increase or decrease in the results of measurements on each individual pressure manometer shows normal conditions, so the results of the experiment liquid jet gas pump using air stabilizer tube is necessary, in order to obtain optimal results and particularly goodness in measuring instrument readings. The measurement P1 results showed measurement with phenomenon and trend graphs up to P1 is on before entering pressure area currently is mixing chamber so the pressure will continue mounting. While at P2, P3 and P4 show graphs with phenomenon continue downhill, the while conditions can be reasoned because of measurements in the area P1, P2 and P3 is on while mixing chamber in conditioning your prayers with two phase flow water and air for a review of the vacuum forming phenomenon with utilize pressurized flow. Also of the figure 3 shows that highest readings pressure measurement lead to secondary flow 30 L / s that is 102.2 Pascal and 6.9 Pascal low vacuum condition.

In Figure 6 also shows that for all primary flow and secondary discharge trends to inform the same thing, that is director air tube in the experiment liquid jet gas pump can affect the measurement results obtained (especially in reading system contained in the measuring instrument). Recommendation of results observations on this research also concluded that the tubes be installed in air director constant conditions without interruption to get good measurement results.

4. Conclusion

From data that has been described in the above discussion, it can be concluded with the increasing flow ratio causes a decrease in the ratio of the pressure so the flow rate decreases motive, with throat diameter of 8.7 mm and throat length is 39.15 mm while the liquid discharge can be varied effect the resulting efficiency. The highest efficiency obtained in liquid discharge 16.82 % with a vacuum level reaches 80.398 kPa.

5. Acknowledgement

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