INTISARI

Fluidyne engine merupakan salah satu jenis *liquid piston Stirling engine* (LPSE) yang memanfaatkan perbedaan temperatur untuk menghasilkan osilasi tekanan dan gerakan kolom cairan. Sistem ini berpotensi digunakan sebagai pompa air sederhana karena tidak memerlukan piston padat dan mekanisme poros engkol. Penelitian ini bertujuan untuk mengkaji kinerja eksperimental *Fluidyne engine* sebagai pompa air dengan variasi *check valve* dan *duckbill valve*. Parameter yang dianalisis meliputi rasio temperatur T_H/T_C *onset*, amplitudo tekanan osilasi, frekuensi osilasi, kerja mesin per siklus, *displacement* kolom cairan, laju aliran, *head*, dan efisiensi pompa.

Pengujian dilakukan pada *Fluidyne engine* dengan panjang *tuning column* (L_3) sebesar 1,66 m sebagai konfigurasi geometri tetap. Sistem diuji pada tiga konfigurasi, yaitu tanpa saluran pemompaan, dengan *check valve*, dan dengan *duckbill valve*. Data tekanan dianalisis menggunakan *Fast Fourier Transform* (FFT) dan pendekatan Lorentzian untuk memperoleh *quality factor* (Q), sedangkan data *displacement* diperoleh melalui perekaman kamera dan pengolahan video. Laju aliran dihitung berdasarkan volume air hasil pemompaan terhadap waktu, sedangkan efisiensi pompa dihitung dari perbandingan daya hidrolik terhadap daya rata-rata *engine*.

Hasil penelitian menunjukkan bahwa pada panjang $L_3 = 1{,}66$ m, pemasangan saluran pemompaan meningkatkan kebutuhan T_H/T_C *onset*. Konfigurasi tanpa saluran pemompaan memiliki T_H/T_C *onset* sekitar 1,17, sedangkan konfigurasi *check valve* sekitar 1,38 dan konfigurasi *duckbill valve* lebih dari 1,40. Frekuensi osilasi relatif konstan pada kisaran 0,62 sampai 0,65 Hz. Hasil ini menunjukkan bahwa variasi *valve* lebih berpengaruh terhadap amplitudo osilasi dan kinerja pemompaan daripada terhadap frekuensi osilasi. Pada T_H/T_C = 2,12 dan *head* 0,5 m, kerja mesin per siklus pada konfigurasi *duckbill valve* 2,01 J, lebih besar dibandingkan konfigurasi *check valve* sebesar 1,16 J. Namun, kerja mesin yang lebih besar tersebut tidak menghasilkan kinerja pemompaan yang lebih baik. *Check valve* menghasilkan *displacement*, laju aliran, *shut-off head*, dan efisiensi pompa yang lebih tinggi dibandingkan *duckbill valve*. Pada *head* 0,5 m, laju aliran maksimum *check valve* mencapai sekitar 17,8 mL/s, sedangkan *duckbill valve* mencapai sekitar 10 mL/s. Efisiensi *check valve* menurun dari 11,4% pada *head* 0,5 m menjadi 6,3% pada *head* 1,1 m, sedangkan efisiensi *duckbill valve* menurun dari 3,7% menjadi 0,26%. Dengan demikian, *check valve* menunjukkan kinerja pemompaan yang lebih baik dibandingkan *duckbill valve* pada konfigurasi *Fluidyne engine* yang diuji.

Kata kunci: *Fluidyne engine*, pompa air, *check valve*, *duckbill valve*, T_H/T_C, *displacement*, laju aliran, *head*, efisiensi pompa

ABSTRACT

Fluidyne engine is a type of liquid piston Stirling engine (LPSE) that utilizes a temperature difference to generate pressure oscillation and liquid column motion. This system has potential for use as a simple water pump because it does not require a solid piston or crank mechanism. This study aims to experimentally investigate the performance of a Fluidyne engine as a water pump using two different types of valves, namely a check valve and a duckbill valve. The analyzed parameters include the onset temperature ratio T_H/T_C, pressure oscillation amplitude, oscillation frequency, engine work per cycle, liquid column displacement, flow rate, head, and pump efficiency.

The experiment was conducted using a Fluidyne engine with a tuning column length (L_3) of 1.66 m as a fixed geometric configuration. The system was tested under three configurations: without a pump, with a check valve, and with a duckbill valve. Pressure data were analyzed using Fast Fourier Transform (FFT) and Lorentzian fitting to obtain the quality factor (Q), while displacement data were obtained through camera recording and video processing. The flow rate was calculated from the pumped water volume over time, while pump efficiency was calculated as the ratio of hydraulic power to the average engine power.

The results show that, at L_3 = 1.66 m, the addition of the pumping line increased the required onset temperature ratio T_H/T_C. The onset temperature ratio was approximately 1.17 for the system without a pump, 1.38 for the check valve configuration, and above 1.40 for the duckbill valve configuration. The oscillation frequency remained relatively constant within the range of 0.62 to 0.65 Hz. These results indicate that valve variation had a greater effect on oscillation amplitude and pumping performance than on oscillation frequency. At T_H/T_C = 2.12 and a head of 0.5 m, the engine work per cycle of the duckbill valve configuration was 2.01 J, which was higher than that of the check valve configuration at 1.16 J. However, the higher engine work did not result in better pumping performance. The check valve produced higher displacement, flow rate, shut-off head, and pump efficiency than the duckbill valve. At a head of 0.5 m, the maximum flow rate of the check valve reached approximately 17.8 mL/s, while the duckbill valve reached approximately 10 mL/s. The efficiency of the check valve decreased from 11.4% at a head of 0.5 m to 6.3% at a head of 1.1 m, while the efficiency of the duckbill valve decreased from 3.7% to 0.26%. Therefore, the check valve demonstrated better pumping performance than the duckbill valve in the tested Fluidyne engine configuration.

***Keywords**: Fluidyne engine, water pump, check valve, duckbill valve, T_H/T_C onset, displacement, flow rate, head, pump efficiency*