Development of a priming instrument for centrifugal pumps

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ABSTRACT

In Egypt, surface irrigation is the most commonly used method comparing with the other irrigation systems in old land. In addition, centrifugal instruments are prevailing used for irrigating fields. However, the major problem who confronts the farmers at operating these instruments is priming it to be operating by filling the water to replace the air in pipes. To be prime the instrument need two men and consumption about 20 to 30 minutes at best conditions, if the foot valve of suction pipe is good. Nevertheless, when the foot valve is breakdown this operation need more time and efforts. To be solvent this problem developed a priming instrument was developed to full the water in suction pipe of centrifugal pump mechanically. Moreover, this develops help and makes the job easily when the pump attachment to gate pipe irrigation method. The objective of the present investigation is to develop and evaluate different methods for priming of centrifugal pumps. The performance was evaluated under the following parameters:

A. Three sources motion of priming (manual reciprocating motion, manual circular motion and mechanically motion).
B. Three air suction orifice diameters (2.5, 3.75, 5.0 and 6 cm).
C. Two suction pipes, with and without foot valve.

The best results were achieved by using mechanically circular motion without foot valve and air suction orifice diameter from 3.75 to 5.0 cm gave the lowest time consumed in priming the centrifugal instrument.

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INTRODUCTION

Egypt is mainly an agricultural country in which agricultural and irrigation technologies play an important role in supporting national economy. About 5.05 million feddan is old land irrigated **by surface irrigation** methods. Also, the Egyptian traditional centrifugal pump is the common pump used in Egyptian fields for lifting water from the irrigation canals to the land surface. **El-Awady (1998)** reported that, the number of diesel operated instruments in Egypt was about 33000 **(according to 1995 enumeration)** most of them are imported in spite of the achievement of old local industry . This variation is related to the difference between the local and the imported kinds in operating power (the local production is between 5 to 15 hp), the imported instruments are distinguished by the better efficiency, and the cheap price specially the Indian types. **Fouad and Abd Elatif (1991)** said that commonly used low lift irrigation instruments in Egypt are the centrifugal instruments. The used types of them are axial flow instruments (fixed), radial – flow instruments (fixed or movable) and mixed – flow instruments (fixed or movable). **Kotteb (1996)** found that the costs of power required to lift the cubic meter of irrigation water for wheat, maize and rice crops were about 0.0046, 0.0045 and 0.0025 L.E/m^3 for the same crops respectively, as a minimum costs for irrigation equipments that used electric power. **Mashour and Mahfoz (1997)** mentioned that the costs of fuel and labor were the main economic variables. They represent about 53.24% of the total annual costs of the movable irrigation instruments.

MATERIAL AND METHODS

To fulfill the objectives of this article, the test performance experiments of the reciprocating instrument were developed and carried out in the Kafr-Bossat village, Talkha, El-Dakhlia Governorate, while the manufacturing of the instrument was conducted in the private workshop with local material.

Instrument structure:

This priming instrument was developed by using a simple reciprocating pump can be fitted on the frame of a peripatetic centrifugal pump (Kirloskar). The priming instrument consists of one vertical cylinder has a diameter of 15 cm, membrane consists of circular leather, 13 cm diameter, fixed in membrane base and carrier of membrane iron rod, 2 cm diameter and source of motion of membrane (manual reciprocation motion, manual circular motion and mechanical motion with starting handle of irrigation unit). Reciprocation handle consists of iron rod (60 cm) fixed with screw in the end of carrier of membrane rod, while, circular handle consists of crank rod fixed on double bearing its number of (6203) on two plates from iron welded in body of reciprocating instrument cylinder. This crank rod reciprocate in vent has wide 1.25 cm and long equal the same long of stroke of membrane (16 cm), this crank rod rotate by circular handle.

The third system of motion has the same mechanism of circular motion, in addition to hoop carry of chain on sprocket beside the flywheel instead of circular handle, control in separate the third system after operating the irrigation unit by foot pedal to detachment tension roller on the chain to pause it. The frame of the priming instrument was mounted with four

screws 1.2 cm diameter on chassis of Kirloskar carriage irrigation unit as shown in Figs. (1.A, 1.B, 1.C and 2).

Fig. (1-A) Manual reciprocating priming instrument

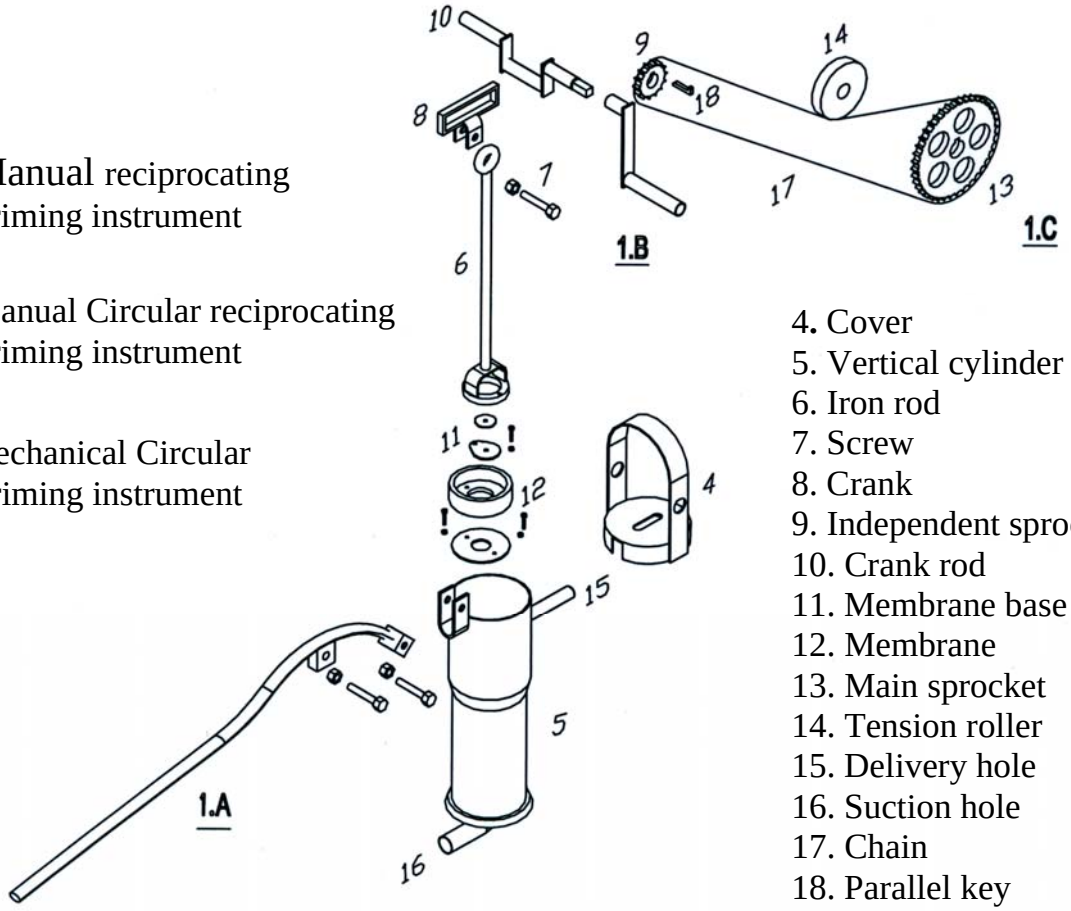
Fig. (1-B) Manual Circular priming instrument

Fig. (1-C) Mechanical Circular priming instrument

1. A Manual reciprocating priming instrument

1. B Manual Circular reciprocating priming instrument

1. C Mechanical Circular priming instrument



4. Cover
5. Vertical cylinder
6. Iron rod
7. Screw
8. Crank
9. Independent sprocket
10. Crank rod
11. Membrane base
12. Membrane
13. Main sprocket
14. Tension roller
15. Delivery hole
16. Suction hole
17. Chain
18. Parallel key

Fig. (2) Isometric of priming instrument and three methods of motion 1.A, 1.B and 1 C.

Study parameters:

The performance of the centrifugal pump was evaluated under the following parameters:

1. Three sources motion of priming instrument (manual reciprocating motion, manual circular motion, and mechanically motion with starting handle of instrument).
2. Four air suction orifice diameters 2.5 cm, 3.75, 5 and 6 cm.
3. Two suction pipes with and without foot valve.

Measurements:

During test performance of the priming instrument, the following items were measured:-

1. **Time consumed of centrifugal instrument priming. (Min.).**

   After each running of machine, the consumed time in filing the water in suction pipe of centrifugal pump calculated with minute to confront between the different systems.

2. **Estimation cost.**

   The total hourly cost of operation could be estimated using the priming instrument price

RESULTS AND DISCUSSION

1. Effect of different priming methods on priming time at different air suction orifice diameters.

During the test performance of the priming instrument, the obtained results for the effect of different filing methods, air suction orifice diameter, and suction pipe control system (foot valve) are showed in Figs. (1.A, 1.B, and 1.C and 2). From the data collected and graphically in fig. (3)

Show that the method of priming the centrifugal pump was arranged according to the lowest time consumed as follows: mechanical circular motion (5.6, 4.7, 4.2, and 3.4 min.), manual circular motion (11.1, 9.4, 7.9, and 6.7 min.), and manual reciprocating motion (14.3, 11.9, 9.7, and 8.6 min.) respectively under different air suction orifice diameter. Also, the time of priming the pump was decreased with increase the air suction orifice diameter from (2.5 to 6 cm) and it was constant at 5 cm. while, any increase in air suction orifice diameter more than 5 cm not gave decrease in time consumed for priming the pump.

2. Effect of different priming methods on priming time by using suction pipe with and without foot valve

At the same time, the results in fig. (4) Indicated same pervious of arranged methods of priming the pump, in fig. (3). But the time consumed at using air suction pipe from 2.5 to 6 cm respectively. With foot valve was little than it without foot valve as follows:

- Mechanical circular motion (5.6, 4.7, 4.2 and 3.4 min.) comparing with (5.1, 4.3, 3.7 and 2.9 min.)
- Manual circular motion (11.1, 9.4, 7.9, and 6.7 min.). Comparing with (9.6, 8.8, 6.5 and 5.8 min.)
- Manual reciprocating motion (14.3, 11.9, 9.7, and 8.6 min.) comparing with (12.9, 10.8, 8.4 and 7.8 min.)

In general, it could be stated that, the optimum parameters that achieved the lowest time consumed in priming the pump noticed at mechanical circular motion, without foot valve and 5 cm air; suction orifice diameter .

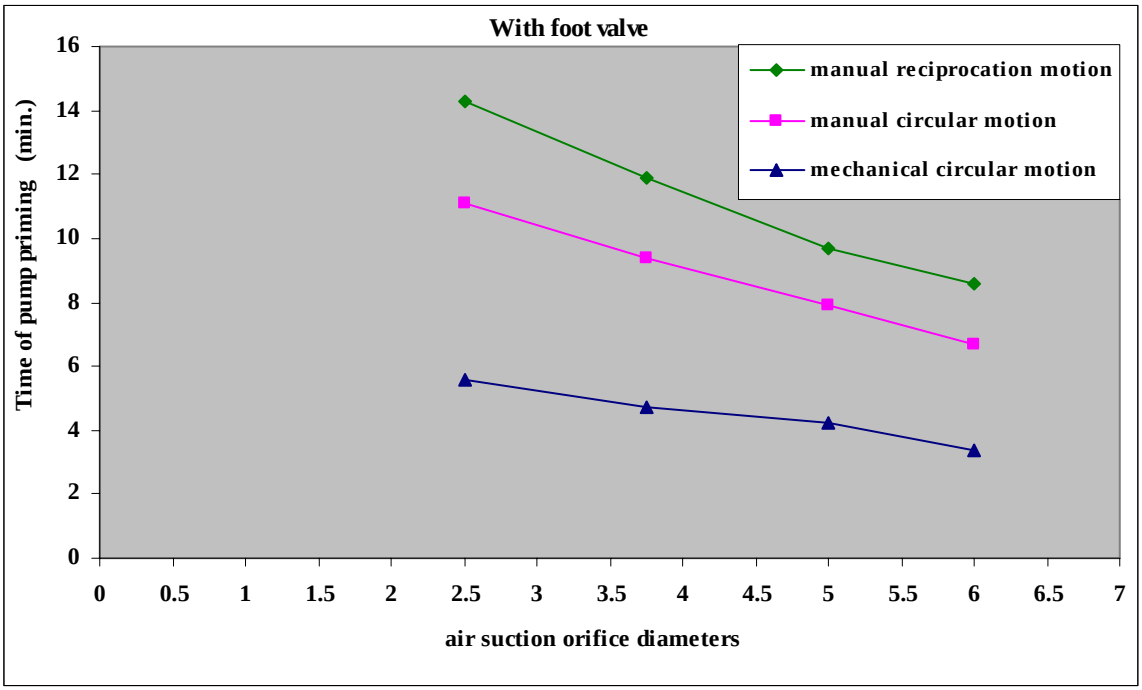


Fig.(3) Effect of air suction orifice diameters, methods of motion, and suction pipe with foot valve on time of centrifugal instrument priming (min.).

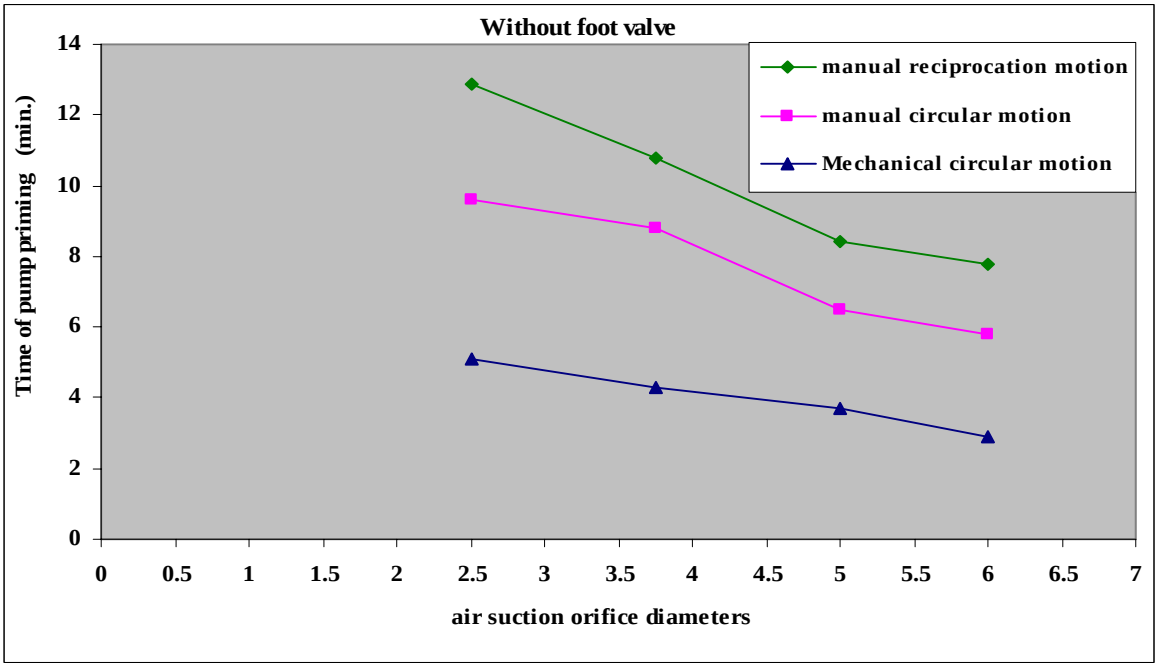


Fig. (4) Effect of air suction orifice diameters, methods of motion, and suction pipe without foot valve on time of centrifugal instrument priming (min.).

3. Operation cost:

The operation cost (LE/h) of the reciprocating instrument was calculated during priming of centrifugal pump under the maximum obtained operation cost was found to be 0.03 LE/h for priming of centrifugal pump.

CONCLUSION

1. The results showed that farmers can be used the developed reciprocating instrument instruction with mechanical source of motion.
2. The optimum operating results showed that suction pipe without foot valve, from 3.7 to 5 cm air suction orifice diameters, and mechanical source of motion. Where gave easily to operate, gait priming of instrument, lowest time consumed and operation cost.

The results of this article may recommend that using the new design reciprocating instrument for priming the centrifugal instrument as supplement unit on carriage irrigation units that spreading in Egyptian countryside.

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المُلخص العربي

تطوير وسيله لتحضير الطلمبات الطاردة المركزية

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يُعتبر الري السطحي واحداً من أهم نُظم الري شيوعاً في مصر بالمقارنة بنُظم الري الأخرى. و الطلمبات الطاردة المركزية على وجه الخصوص والموجودة بماكينات الري النقالي هي الأكثر انتشارا في الريف المصري لري الحيازات ألصغيره (حوالي 33000 ألف طلمبة. العوضى 1998). والمشكلة التي تواجه مثل هذا النوع من الطلمبات هي عملية تحضير الطلمبة بالمياه لإدارتها وذلك عن طريق ملئها بالماء وهذه العملية تحتاج إلى رجلين للتمكن من رفع المياه من المجرى المائي وتوصيلها إلى الطلمبة مستغرقةً في ذلك من 15 إلى 20 دقيقه على أحسن تقدير وذلك عندما يكون بلف أنبوب رفع المياه سليم. أما عندما يكون هذا البلف معطوب فإن العملية تكون أكثر استهلاكا للوقت والمجهود. كما أن تحضير الطلمبة بالمياه تعتبر من المعوقات الرئيسية عند استخدام الأنابيب المبوبة في الري السطحي المطور.

ومن هذا المنطلق كان التفكير في وسيله جديدة لتحضير الطلمبة وذلك باستعمال طلمبة ترددية ذاتية التحضير صنعت بالورش المحلية من أدوات بسيطة وذلك لاستعمالها في سحب الهواء من الطلمبة الغير ذاتية التحضير وإحلال الماء محله. وقد تم تقييم أداء الآلة المصممة عند أربعة أقطار لفتحة سحب الهواء من طلمبة الري (2.5 ، 3.75 ، 5 ؛ 6 سم) و استعمال أنبوب رفع المياه ببلف وبدون بلف و ثلاث نُظم لإدارة طلمبة التحضير (يدوياً عن طريق يد ترددية الحركة ، يدوياً عن طريق يد دائرية الحركة ،ميكانيكياً أثناء إدارة ماكينة الري عن طريق جنزير بشدادة بين الطلمبتين).

ولقد أوضحت النتائج إماكنية استخدام وسيلة التحضير المصممة بكفاءة عالية حيث تعطى أقل وقت لتحضير الطلمبة 2.9 دقيقه وذلك لبساطة تصنيعها بالورش المحلية ورخص ثمنها وتوفيرها الوقت والجهد. حيث أنها تتميز بما يلي:

1. توفر 88% من وقت التحضير اليدوي.
2. يمكن الاستغناء عن البلف السفلى وتلافى مشاكل أعطاله المتكررة.
3. النظافة العامة والتقليل من التلوث بمياه الترع للعمال الزراعيين.

وتوص الدراسة بأن أنسب ظروف تشغيل لطلمبة التحضير عند فتحة سحب الهواء من 3.75 إلى 5 سم وأنبوب رفع المياه بدون بلف و أن تكون إدارة وحدة التحضير ميكانيكياً عند إدارة ماكينة الري. أيضاً يمكن استخدام هذه الآلة كوحدة مُلحقه على ماكينة الري النقالي والمنتشرة بكثرة في الريف المصري.

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